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ABSTRACT

During 1979, nine National Workshops were organized in Afghanistan, India, Japan, Malaysia, Nepal, Philippines, Sri Lanka, Thailand, and Socialist Republic of Vietnam to analyze national experiences relating to the designing and developing of innovative science curriculum and instructional materials for linking science education to real-life situations. This document presents highlights of these national workshops. Topics presented include, among others, units of activities related to real-life situations, problems and issues in science education, a list of some "how to make" low-cost science equipment, pre-service and in-service programs, implementation considerations, and recommended activities to follow-up the workshops. (SK)

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ASIAN PROGRAMME OF EDUCATIONAL INNOVATION
FOR DEVELOPMENT

Curriculum development:

Linking science education to life

Report of a Sub-regional Workshop
on Designing and Developing
Innovative Science Curriculum
and Instructional Materials
Bangkok, 8-20 December 1980

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Chapter I

INTRODUCTION

Background

During 1979, nine National Workshops were organized in Afghanistan, India, Japan, Malaysia, Nepal, Philippines, Sri Lanka, Thailand and Socialist Republic of Viet-Nam, to analyse national experiences relating to the designing and developing of innovative science curriculum and instructional materials for linking science education to real-life situations. Two participants each from these nine countries then met at Colombo in a Sub-regional Workshop (first series) in December 1979, to synthesize the national experiences and develop guidelines and make suggestions for follow-up activities and further improvement of science education programmes in their countries.*

As the second series of the above activity, the present Sub-regional Workshop on Designing and Developing Innovative Science Curriculum and Instructional Materials (second series) was organized jointly by the Institute for the Promotion of Teaching Science and Technology (IPST), Thailand, and Unesco's Asian Centre of Educational Innovation for Development (ACEID), Bangkok, from 8 to 20 December 1980 at the IPST, Bangkok.

Prior to the Sub-regional Workshop (second series), a Preparatory Group Meeting was organized in May 1980 to develop guidelines for the organization of National Workshops and this Sub-regional Workshop. During the months of August to November 1980, four of the participating countries, namely, Bangladesh, Indonesia, Rep. of Korea and Thailand, organized the National Workshops to deliberate on national experiences relating to the designing and developing of innovative science curriculum and instructional materials with focus on linking science to real-life situations and for this purpose using the environment and preparing low-cost science equipment to provide the necessary science teaching/learning experiences.

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* "Linking science education to real life: Curriculum design, development and implementation" - Report of a Sub-regional Workshop, Unesco, Bangkok 1980.

Purpose of the workshop

The main purpose of the Workshop was:

i) to share experiences gathered from the national-level workshops and identify problems, growth points and methodologies of innovative projects,particularly those based on real-life experiences with focus on the use of locally available resources and environment as an alternative to and as compliment of laboratories;

ii) to develop guidelines for designing, developing and implementing of science curricula based on the materials derived from and linked with real-life situations and employable skills associated with them, using the environment and local resources;

iii) to suggest alternative methods for preparing teachers in science and technology for implementing science curricula related to real-life situations and using environment and local resources; and

iv) to recommend follow-up activities both at the national and sub-regional levels.

Participation

Nine participants, two each from Bangladesh, Indonesia, Rep. of Korea and Thailand and one from Pakistan, participated in the Workshop. In addition, two observers from IPST, Thailand, and the Science Education Specialist from ACEID also participated in the Workshop. The list of participants and observers is in Annex I.

Inaugural session

The Workshop was inaugurated by Dr. Saiyut Champatong, Deputy Under-Secretary of Education, Ministry of Education, Thailand. In his inaugural address,extending a welcome to the participants, Dr. Saiyut expressed the hope that the Workshop will provide a unique opportunity for a wide exchange of experiences and outcomes obtained from the National Workshops which have been held in each participating country, and these in turn would be most beneficial to the participating countries as well as Thailand in dealing with the improvement of science curriculum more effectively, in particular with a view to link the curriculum to real-life situations.

The inaugural session was also addressed by Mr. Raja Roy Singh, Assistant Director-General, Unesco Regional Office for Education in Asia and the Pacific, who welcomed the participants on behalf of Unesco and pointed out the rich experience which IPST has generated during the last decade of its work and is serving as a beacon-light in the science education developments in the region, and this the participants would be able to share during this Workshop.

Method of work

During the first plenary session, the participants elected Dr. Thongchai Chewprecha (Thailand) as Chairman; Miss Ratna Wilis Dahar (Indonesia) and Prof. Chung Yun Tai (Rep. of Korea) as Vice-Chairmen; and Dr. Bazlul Haque (Bangladesh) and Mr. Sheikh Abdul Quasim (Pakistan) as Rapporteurs.

The Workshop then adopted the agenda and the schedule of work. The next five plenary sessions were devoted to the presentation of and extensive discussions on experiences of the National Workshops. This was followed by a two-day field trip to make an on-the-spot study of some science teaching and teacher training programmes which were attempting to establish links with the real-life situations. The field trip also enabled the participants to see the various natural environmental resources which could be used profitably for making science education more relevant to daily life needs. The Workshop then, through group work and plenaries, developed suggestions for designing and developing innovative science curriculum and instructional materials linking them more and more to real-life situations, and on alternative approaches for preparing science teachers to implement such curricula.

In the penultimate session, the Workshop made suggestions for follow-up actions both at national and sub-regional levels.

In the concluding session, the Workshop considered its report and adopted it with modifications, which have been incorporated in this final report.

Chapter II

HIGHLIGHTS OF THE NATIONAL WORKSHOPS

Prior to this Sub-regional Workshop, four of the participating countries namely, Bangladesh, Indonesia, Rep. of Korea and Thailand organized National Workshops using the guidelines for the organization of such workshops developed by a Preparatory Group Meeting held in May 1980 in which these countries had participated. Pakistan, however, could not complete this Workshop.

In this Chapter are embodied some of the highlights of the national experiences as they were discussed in these Workshops. Additional information, particularly in respect of structure of school education and the place of science teaching in the school curricula, have been incorporated in the presentations to give the reader an idea of how science education is organized in the participating countries. Information regarding Pakistan is based on the paper presented by the participant from that country.

All the National Workshops had as one of their objectives to prepare some 'How to do, How to make' instruction sheets to help teachers to develop some simple science teaching equipment using locally available materials and the environment. The titles of different science equipment items that were developed in these National Workshops are included in Annex III of this report.

The National Workshops also made certain recommendations for actions both at the national and regional levels which would promote the linking of science teaching to real-life situations and these have been taken into consideration by the Sub-regional Workshop which has made its suggestions for the same purpose in Chapter V of this report.

BANGLADESH

Introduction

The National Workshop was held in Dacca from 8 to 18 September 1980 in which 25 persons representing science curriculum developers, teacher educators, teachers, equipment designers, educational researchers, psychologists and staff of community development, agriculture and nutrition departments participated.

Considering the inadequacies and failures of the science curricula that have been followed in the past, a new national curriculum for science education has been developed for various levels of school education. The new science curriculum has already been introduced at the primary level and at the other levels it is in the process of being implemented. In the new curriculum, a deliberate attempt has been made to link science education to real-life situations and the immediate environment of the learner and also for the development of productive and employable skills and work attitudes.

The National Workshop made a critical review and analysis of the curriculum, the teacher training programme and the national efforts and experiences in equipment development with a view to identify and suggest: the incorporation of additional curriculum offerings using environment and local resources, so as to make science teaching more closely related to the real-life situations of the learners; to identify competencies and skills required to handle the new curriculum and suggest strategies for developing these skills and competencies; and to develop exemplar 'How to make' equipment instruction sheets and instruction modules.

Structure of science education

The school science education in Bangladesh is divided primarily into three different levels:

i)	Primary level (I-V)	:	5+ to 9+ years
ii)	Lower secondary level (VI-VIII)	:	10+ to 12+ years
iii)	Secondary level (IX-X)	:	13+ to 14+ years
iv)	Higher secondary level (XI-XII)	:	15+ to 16+ years

The higher secondary level of education is considered as the college level of education (pre-university).

Current innovations

'Environmental Study' has been conceived as a separate discipline in the new curricula and has been introduced from the very beginning of the primary level of education. In the new subject information and basic concepts and principles of both natural and social science have been incorporated so that the learners are exposed to these from the very beginning of their lives.

At the lower secondary stage 'Environmental Study' continues, but within its framework efforts have been made to teach natural science in an integrated fashion based on the knowledge and experiences gained at the primary stage.

The science course at the lower secondary stage contains the elements of natural sciences like physics, chemistry, biology as well as geography, hygiene, health education and population education.

Linking science education to life

A new subject called 'General science' is to be introduced soon at the secondary level in place of the existing physics, chemistry, elective mathematics and biology. This is as a result of the abolition of the existing 'group system' at the secondary level.

In order that the learners gain work experience in socially useful productive activities, work-oriented education has been included in the curriculum at the lower secondary and secondary level as a compulsory subject. With a view to make the activities associated with the work-oriented education relevant to the rural and urban settings of the learners, the following four areas have been identified for drawing elements of work-oriented education:

i) agriculture;

ii) industry;

iii) social work; and

iv) home economics

All of the above four would have the relevant science principles and concepts built into their courses and interacting with the existing science courses.

The main thrust of work-oriented education in the secondary curriculum is not on formal training in employable skills for earning a living, but on developing a positive and healthy attitude to manual and productive work and to give them some preliminary orientation in the proper skills development in real-life situation as well as to understand the scientific principles involved in appropriate technology.

Technical education and vocational training are given in the framework of a formal curriculum and institutional arrangements for this are found in the Polytechniques, Vocational Training Institutes, etc.

For the general stream of secondary education, non-formal type of skill-training has been proposed to be given by designing curricular courses relevant to the productive and economic activity of the community for the out-of-school youths, including the school drop-outs and those in the general stream who may opt for such courses. These courses will not be tied to a formal structure of rigid courses and examination requirements. These courses will be offered as evening trade courses in vocational training institutes, and in selected rural high schools by establishing at these institutions the minimum workshop and laboratory facilities.

For skills training, 'Community schools' have been proposed, which are envisaged to meet the need of the community for skilled manpower and create a facility to help people get training for being gainfully self-employed. Courses to be offered in the community schools will be so designed as to leave sufficient scope and

flexibility to use relevant establishments and projects like agricultural farms, community projects, indigenous industries, for practical experience and on-the-job training.

Major problems and issues

The new curricula have been developed and introduced at the primary level and are going to be introduced soon at other levels of school education. A variety of problems and issues are expected to be faced, particularly under the present situation prevailing in the country. Some of these are the following:

i) Teacher component

Shortage of qualified science teachers; inadequate skills and competencies to handle a curriculum which is linked to real-life situations; inadequate time for effective teaching; inadequate equipment and instructional materials; lack of motivation and interest; lack of opportunities to participate in curriculum development; lack of adequate funds for science teaching; unattractive salary and service conditions; inadequate exposure and orientation to the new curricula linked to real-life situations; inadequate knowledge and training in the use of equipment, environment and local resources; lack of knowledge and competencies in preparing lessons and out-door activities for linking science to real-life situations and using the environment; lack of skills in making simple equipment for classroom teaching; and lack of appreciation for hard work, merit and creative activities.

ii) Learners

Lack of interest and motivation; over-crowded classrooms hampering activity oriented programmes; inadequate opportunities for participation in experiments and activities, both in and out of the classrooms; lack of appreciation and recognition for hard work, merit and creativeness in evaluation of the learning outcomes.

iii) Institutions and the community

Lack of provision of adequate funds for practical experiences; lack of equipment and physical facilities for science teaching; lack of facilities for development, repair and maintenance of science equipment; lack of supervision and professional support; and lack of community involvement.

Examples of content/topics linking science to real-life situation

Primary level

'Environmental study' has been conceived as a separate discipline and introduced at the very beginning of the first level of education. In this subject, which is interdisciplinary in nature, information, concepts and principles basic to both natural and social sciences, have been incorporated to expose the learners to

these from the very beginning of their lives, thus providing an excellent opportunity to link science learning to the real-life problems.

Classes I and II

No book is prescribed. The teacher is to prepare the lessons and activities on topics relevant to child's immediate natural and social environment. The teacher will be supplied with a teacher-guide. Almost all the topics are closely related to the real-life situations. Following are the major science topics included in various classes of primary school which have a direct link with real-life situations:

Class III:

the earth and the universe: sun, moon and stars; earth's surface: soil, water, air and weather; the living world; conservation of the environment: maintenance of live-stock, poultry, care of plant life, care of wild life; and stories of inventions.

Class IV:

human beings and the environment; earth and the universe; the non-living world: characteristics of earth's surface, hills and mountains, valleys, plains and delta, rivers, seas and gulfs, lakes; soils: different kinds of soils and appropriate crops; water: three states of water, water-cycle, use of water, water borne diseases and their prevnetion; purification of water; air: constitutents of air: oxygen, nitrogen and carbon-dioxide; necessity of oxygen in burning and in respiration of living objects; air-borne diseases and their prevention; pressure of air, air-current; weather and climate, matter: three states of matter; molecules and atoms, elements and compounds; the living world: plants and their varieties, different parts of plants, flowers and fruits, environment and plants; animals: external organs of animals, chordates, mammals, birds, amphibians (fish), environment and animals, importance of plants and animals; food: balanced and unbalanced, importance and ways of conservation of food; influence of weather and climate on animal and plant-life; cultivation of vegetables, flowers and fruits in different seasons; health and environment: pollution of water and air, relation of pollution of environment with expansion of population and habitation, health care against flies and mosquitoes; conservation of the environment: erosion and prevention, preservation of plant and bird life in urban and rural settings; conservation of forests and wild-life; and stories of inventions.

Class V:

human beings and environment; the earth and the universe; daily and annual rotation of the earth; change of seasons and their characteristics; the non-living world; plants, forests and animals depending on regional soils in Bangladesh; soil-fertility; weather and agriculture; matter and energy; heat and sound; electricity and light;

the living world, the animal world; birds' habitation; fish and their breeding places; interdependence of plants and animals; food chain; health measures: first aid, food, nutrition and population, population growth, food problem and importance of looking at it from scientific point of view; agriculture and its development; various ways of developing agricultural products; mineral resources of Bangladesh; and stories of invention.

For each class detailed content is prescribed in the syllabus as also the guide for the teachers as to what to teach. Teachers' guides are being developed for distribution to the teachers.

Training of teachers

The on-going teacher training programmes in Bangladesh included both the pre-service and in-service training of teachers of the primary and secondary schools. As there are no separate teachers designated as science teachers at the primary level, the teachers are offered training in science as part of their over-all training programme in the 48 government and 3 privately managed Primary Teacher Training Institutes. The Institute of Fundamental Education offers specialized training for the primary school teachers and supervisors where the trainees are exposed to some orientation in the aspect of improvisation of educational equipment. Science teachers for secondary schools are given pre-service training in the 10 government teachers' training colleges, and at the Institute of Education and Research which offer training courses for graduates for all school disciplines. Technical Teachers' Training College offers training to the teachers of the polytechnic institutes.

In-service training courses of varied duration, from two weeks to two months, for science teachers of secondary schools are offered at the Bangladesh Education Extension and Research Institute (BEERI). Bangladesh Educational Equipment Development Bureau (BEEDB) gives a brief orientation on the use and maintenance of equipment and teaching aids developed at BEEDB to the secondary and higher secondary science teachers coming for training at the BEERI. The Audio-visual Education Centre offers courses of two week's duration on the use of audio-visual materials in which science teachers of primary and secondary schools participate.

The pre-service as well as the in-service training programmes still follow the traditional strategy without giving sufficient attention to prepare the teachers with competencies and skills for attempting meaningful correlation between science education and real-life situations.

The primary teacher training programme has so far been general in nature without giving any attention to make science teaching relevant to the real-life situations of the learners.

Linking science education to life

Both the in-service and the pre-service teacher training programmes have so far not included specialized training for improvisation of simple science equipment and teaching aids.

There is yet no effective follow-up system to motivate and encourage the teachers in making science teaching-learning real-life based and to lend adequate professional support.

Recently the primary teachers have been given a short orientation in the new science curriculum linked to real-life situation through methods aimed at multiplier effect and downward filtration. However, in such a process the teachers do not get adequate grounding in the information, concepts, principles and the methodologies of science teaching, since the message gets diluted in the process of downward filtration.

The National Workshop identified the teacher as the main factor controlling and manipulating the teaching-learning situations. In the science curriculum, which has been developed and adopted in Bangladesh, with linkage to real-life situations of the learners, the science teachers have to play certain new roles for which new skills and competencies have to be developed. The Workshop identified some of the skills that are considered necessary for the science teachers to acquire in the new situation. The situation, the appropriate skills and competencies, and the strategies suggested for developing those are summarized below:

New situations	Skills and competencies required	Strategies suggested
1. Teaching productive skills	Certain specific vocational skills and background academic knowledge	a) Short-course training in relevant vocational skills b) Skill development programmes based on the needs of the community and national development goals should be provided along side academic programmes c) Skill development courses in the in-service and pre-service training programmes should be provided
2. Use of local resources as sources of teaching-learning process	Skills of identifying, selecting and conserving materials from the environment for probable use as instructional materials	a) Specific courses should be organized in the in-service and pre-service training programmes b) Short-course training during vacation periods through professional institutions and agencies

New situations	Skills and competencies required	Strategies suggested
2. (cont'd.)	Competency for exploring and establishing community resource persons' involvement	c) Short-course training should be given to explore, identify and establish mechanism for promoting effective involvement and active participation of local expertise, including government and other related agencies, in designing innovative curricular projects based on real-life situations and community needs, and also in playing active role in assisting the teachers in running such projects and in teaching specific science lessons in the schools, if necessary by providing honoraria to the local experts.
3. Development of low-cost equipment	Design and construction skill, knowledge of materials used and understanding of educational needs	a) Teacher training programmes should include courses on identification and use of local materials, particularly those found in the environment; design and development of low-costg equipment; and in the understanding of educational needs. b) Design and development of at least 1-2 low-cost educational equipment should be made an integral part of this training programme. c) Short in-service training courses should be offered for a) and b) above. d) 'How to make' instruction sheets on low-cost equipment and list of unutilized and under-utilized materials found in the community should be made available to the school science teachers. e) Dissemination of information on equipment development and relevant materials should be arranged.

New situations	Skills and competencies required	Strategies suggested
4. Use and apparatus application of educational equipment	Manipulative skills and understanding of appratus application	a) Courses on the use and apparatus application of equipment should be offered as an integral part of the teacher training programme, both in the pre-service as well as in the in-service. b) Short training programmes should be organized at the national equipment centre. c) Information on the use and apparatus applications should be disseminated regularly to the school science teachers.
5. Maintenance and repair of equipment	Skills in maintenance and repair of equipment	a) Courses should be organized as integral part of the pre-service and in-service training programmes. b) Short training programmes should be organized at the national equipment centres. c) A set of hand-tools should be provided to the school science teachers. d) Information on maintenance and repair of equipment should be disseminated to the school science teachers regularly. e) Mobile repair teams should be organized to brief and train school science teachers in the area on repair of equipment.

The importance of re-organizing and strengthening the teacher training programmes, both in-service and pre-service, as well as training the teachers for developing needed skills and competencies for handling the new science curriculum linked to the real-life situations have been recognized. Plans and programmes are being developed to introduce appropriate courses in the teacher training programme to develop these skills and competencies, and to prepare the teachers so that they can improvise simple low-cost equipment for use in their lessons.

INDONESIA

Introduction

The National Workshop was organized by the Office of Educational and Cultural Research and Development (BP3K) in co-operation with ACEID from 22 to 30 September 1980. It was meant to discuss the existing innovative efforts being made to link science education to real-life situations; identify examples of real-life situations which could be incorporated in the existing curricula; suggest strategies for designing and developing science curricula linked to real-life situations and productive skills; identify teacher competencies and skills needed to implement this new teaching approach; suggest strategies for training of teachers; and develop some exemplar 'How to make' instruction sheets for selected low-cost equipment items using locally available resources.

The 25 participants were science curriculum developers, teachers, teacher educators, equipment designers and developers, educational researchers, and representatives of other ministries and organizations.

Besides, some people having critical views on science education were also invited to the Workshop as resource persons.

Structure of science education

Science is taught as a separate subject at the elementary and junior high school; as a general science course covering topics on biology, physics, chemistry, earth and space science during one semester of the senior high school for all students; and as separate subject courses in chemistry, biology, physics and earth and space science during five semesters of the senior high school for those students who are majoring in science and mathematics.

The science courses at all levels comprise of the development of concepts, their inter-relationships, scientific skills, attitude[redacted] and appreciation of nature, through lecturing, demonstration, experimenting and field work.

Textbooks and Teachers Guides have been written for all the grades of primary and junior high schools, and for some grades of the senior high school.

The assessment procedure comprises of: a formative test at the end of each unit lesson consisting of objective type items; a summative test at the end of a quarter term for the primary school, and at the end of a semester for the secondary schools consisting of objective type and essay type items. At the end of each level of education, students are required to take a final examination.

Linking science education to life

Teachers are asked to develop simple equipment, or use the environment in teaching science. For the primary schools a science kit is under mass production, while the state junior high and senior high schools are almost all furnished with science equipment and a science laboratory.

Throughout the teaching-learning process, the enquiry approach is recommended, with a stress on student activity.

Innovative efforts to develop science and technology education linked to real-life situations

Some projects which bear the potential to develop science education linked to real-life situations and productive skills are the following:

i) The Development Schools Project being implemented in eight pilot schools since 1975, focuses on the curriculum development of primary school (5 years), junior high school (3 years) and senior high school (3 years) using the modular approach. Some of the modules written for the students are on topics which are related to real-life situations, such as erosion, nutrition, water purification, simple machines, ecology, fertilizers. Although the basic course outline has been developed, and modules have been written for all the classes, the Workshop was of the opinion that it is still possible in the revised edition, to relate more topics to real-life situations.

ii) The Open Junior High School Project started in 1979 has been developed to give educational opportunities to an increasing number of primary school graduates, using modules which can be studied by the students at home or at certain centres. In developing the mocules efforts have been made to link several science topics with real-life situations.

iii) The Environmental Education Project aims at improving the quality of the environment through the education of children so that they have a positive attitude towards their environment. Topics have been selected from the existing primary school curriculum and unit lessons or modules have been developed for those topics.

iv) The Development Agricultural School Project is aimed to produce technicians of secondary education level in the development of agriculture in the rural areas. The teaching of science is adapted and oriented towards the needs in the field with a programme that is based on the principle of relevance and efficiency.

v) The Population Education Programme tries to relate population growth and harmony with the environment. This programme has, since 1976, been integrated into several relevant fields of study of the existing curriculum of the primary and secondary schools. At the Institute of Teacher Education (IKIP) and at non-formal education programmes, population education is treated as a separate subject.

vi) The Pamong Project focuses on the delivery system of primary school education, by using the modular approach. The science modules which have been developed make extensive use of the environment, community resources, local expertise and low-cost equipment. The modules can and may be utilized for in school and/or out-of-school education.

Examples of topics on science linked to real-life situations

For identifying topics on science which can be linked to real-life situations, several approaches can be used. In the first approach, we can start from selecting the topics from the existing curriculum and then try to relate them to the real-life situations. In the second approach we try to find problems in real-life and then find topics in the curriculum to solve these problems. Indonesia has followed the first approach. Several topics for the primary school, junior high school and senior high school have been identified. Some examples are given below:

Topics	Real-life situation	Grade	School
Air and wind	The use of a fan to make fire The use of a bicycle pump The direction of the wind	1	Primary
Fresh air	The use of ventilation at home	3	"
Vitamins	The choice of fruits and vegetables which are rich in vitamins for daily consumption	3	"
Erosion	Preventing erosion by growing plants in the garden, school-yard or neighbourhood	4	"
Simple machines	The use of simple machines to help us to do our work	5	"
Cleanliness and health	How to keep ourselves clean and healthy	6	"
Force and pressure	The use of instruments to measure the pressure of gas in our daily environment	1	Senior high
Air pollution	How to prevent air pollution caused by garbage, exhaust gases from vehicles, chimneys, etc.	3	"
Water pollution	How to prevent water pollution	3	"
Food and health	The selection of food that meets the five requirements for nourishment: meat, fish, rice, vegetables, fruit and milk	3	"

Topics	Real-life situation	Grade	School
Cleanliness of the individual and the community	How to keep ourselves and the environment clean and healthy	3	Senior high
Protection and preservation of nature	Participation in efforts to protect and preserve nature	2	"

Training of teachers

A. Pre-service

The training of primary school teachers is conducted in the Teacher Education Schools (SPG) for three years after lower secondary school. The curriculum of the Teacher Education School provides general courses, education courses and specialized courses.

The training for secondary school teachers is conducted in the Institutes of Teacher Education (IKIP). These institutes have six faculties, one of which is the Faculty of Science and Mathematics Education (FKIE). As far as the training for secondary teachers is concerned, there are four types of training programmes organized by the institute -- D1 and D2 programmes for preparing lower secondary teachers and D3 and S1 programmes for preparing upper secondary teachers.

B. In-service

i) Regular programmes

The training programmes of both primary and secondary science teachers involve two major steps. The first step includes the training of the trainers which is held at the national level. In the second step, these trainers then train the teachers at the regional level.

The training of teachers at the regional level is facilitated by the establishment and use of a regional training centre for science teachers.

ii) Innovative programmes

Besides the regular way of training described above, new strategies are being developed to improve the skills of science teachers in implementing the curriculum:

a) In-service - On-service training approach

This approach is now being used to train secondary science teachers. In this approach, teachers are invited to plan instructional programmes for each semester and then implement the programmes in their schools. Regular meetings are then organized to discuss experiences and problems faced during the implementation of the programmes and identify possible solutions to the problems.

b) Supervision Model Approach

This approach of using supervision as a means for providing professional support to teachers is now being developed for primary teachers. In developing this supervision model, techniques, materials and guidebooks for supervisors at the national, regional as well as school levels are being prepared for small scale trials in West Java.

In conjunction with the idea of relating science education to real-life situations, training programmes are focused on developing teacher skills in applying the new approach to implementing the existing curricula.

Simple equipment

Science educators have long realized that besides the factory-made laboratory equipment that is usually sophisticated and costly, there is also a lot of simple and inexpensive equipment that can be produced either by a factory or by the teacher himself. In certain cases teachers can make simple equipment that might cost nothing at all. The materials used for such equipment usually consists of discarded materials. To make this kind of equipment, teachers need to have some manual skills, imagination and creativity, which are all based on a mastery of the subject matter, teaching approaches and methods. Without mastery of these, it is hard for teachers to create simple equipment and make effective use of it.

Samples of simple low-cost equipment developed at the National Workshop are mentioned in Annex III.

Major problems and issues

The following are some of the problems and issues which need to be considered in the effort of relating science education to real-life situations:

a) Problems relating to the content of the existing curricula

The content of the existing science curricula is somewhat over-crowded. In order to be able to cover all the content set for a given year, teachers are tempted to use traditional methods in teaching most of the topics found in the curriculum without making any effort to relate it to real-life problems;

b) Problems relating to the actual competencies of the existing teachers

Many science teachers, particularly at the secondary level, are categorized as underqualified and this reflects on their actual performance in the classrooms. Under a less adequate supervision system, as the country has now, it will take some time for the teachers before they can acquire the competencies needed to implement the new approach, including the capability to identify and use the appropriate equipment.

c) Problems relating to the existing examination system

The type of examination practised in the schools does not encourage the teachers to stress on the process aspect in the teaching of science. The teachers are inclined to focus their teaching on equipping their students with knowledge (product of science) which is commonly asked in the examination. In other words, the existing examination system is preventing teachers from developing process skills in the students and thus rules out any attempts to link science learning to real-life situations which lend themselves best to the processes of science rather than its product.

PAKISTAN

Introduction

Science appears as a subject component of the compulsory core right from Grade I. The concepts-based primary science programme is carried on upto Grade VIII under the title of 'Pakistan Elementary Science Curriculum'. It is an integrated design with a conceptual orientation.

As the pupils enter the two-year secondary course at Grade IX, they are required to make a choice between the humanities and science group of courses. The humanities pupils do a two-year course in general science while the science group pupils do two year courses in separate sciences - physics, chemistry and biology.

At the higher secondary level - XI to XII grades - the pupils completing the physics, chemistry and biology courses at the secondary level can continue with these subjects for a further two years preparing for university and professional education in scientific fields.

Science curriculum reforms

The last cycle of curriculum renovation in Pakistan began in early 1973, starting with primary and leading upto the secondary level. The curriculum for elementary science (primary and middle grades) was redesigned and new curriculum materials were produced.

The primary science programme

The new curriculum for the primary grades is an integrated design with a conceptual framework. The concepts are sequentially structured leading from the very simple to more complex. An attempt has been made to achieve a psychological grading of the concepts, taking into consideration the stages of intellectual development in young children. A curriculum booklet published by the Federal Ministry includes the list of concepts for Grades I-V and advocates an activity approach for the development of these concepts. The following curriculum materials have been produced:

a) A curriculum booklet which provides a list of concepts for each grade. The concepts at each grade are divided into three broad areas - living things, matter and energy, and earth and universe, which are closely related to real-life situations.

b) Textbooks for pupils: The new textbooks incorporate the activity approach and include a number of open ended questions stimulating thinking and exploration by the pupils. Although the curriculum is uniform for the whole country, the textbooks and teachers' guides are developed by the provincial textbook boards, thus relating the concepts to the local environment. Diversity and relevance to local environment is thus achieved in spite of the uniformity imposed by a centralized curriculum.

c) Teachers' guides: The guidebooks for teachers developed by the provincial curriculum bureaus in collaboration with the provincial textbook board fully illustrate the activity approach to the development of science concepts. The activities suggested for the pupils provide experiences with objects, events, peoples, and places. All activities make use of locally available materials and attempt to utilize the real-life situations. The guidebooks are made available to all practicing teachers free of cost.

d) The national teaching kit: A kit containing about 105 items, 80 of them particularly related to science, has been developed and supplied to all primary schools. A manual describing activities that can be performed with the kit items goes along with the kit. The teaching of the primary science curriculum, being activity-based, requires the use of a lot of material. The kit provides only a model to the teacher of how the use of materials can enrich his teaching and make it more effective. The prime purpose of the kit is to stimulate the teacher to make use of materials in his daily teaching. For that purpose, the kit includes a tool box. The tools can be used by the teachers for devising their own teaching aids.

Middle stage science

The middle stage science (Grades VI-VIII) is a continuation of the primary science and uses the same concepts based on design and activity approach to teaching. Except for the curriculum booklet and the pupils' texts, no other specific materials have been produced.

The secondary science courses

The general science course for the humanities group of pupils - the non-science group - is a sort of a combined science course using selected topics from the different disciplines of science, particularly physics, chemistry, biology, geology and astronomy. It is basically a knowledge course attempting to provide an awareness of the broad areas of science, its history, the scientific

method and the social content of science, relating science to some of the major problems of the country such as the energy crisis, population, pollution and conservation of resources.

Pupils choosing the science group take courses in the separate sciences - physics, chemistry and biology. The courses in the three disciplines are mainly preparatory courses for further education in science. The two-year courses end up with examinations in theory as well as practicals.

The higher secondary science courses

Pupils leaving the secondary school with science group certificates can take further two-year physics, chemistry and biology courses at the XI-XII grades. This is the final preparation for higher education in scientific fields like medicine, engineering, technology or pure science leading up to the degree level. The courses are designed primarily to cater for the needs of university science education.

The efforts at innovation

The awareness of the need for the improvement of education in general and science education in particular has given rise to new thinking on curriculum and methods at the various levels. This has resulted in the undertaking of fresh and innovative curriculum projects briefly described below.

Integrated primary curriculum

The attempt at making teaching-learning more and more child-centred at the primary level has led to the thinking that separate subjects are not relevant to the needs of the child. What the child needs at this stage is the maximum opportunity to interact with the environment, both the material and the social environment - and opportunities to meaningfully interact with the real-life situations.

The project titled 'Integrated Primary Curriculum', undertaken by the Curriculum Wing of the Federal Ministry, in collaboration with provincial Curriculum Bureaus, has developed pupil's text, teacher's guide, and some teaching aids. The materials are now being tried out in a random sample of primary schools all over the country.

Integrated science for secondary grades

The streaming into humanities and science groups at Grade IX requires the child at age 13 to make an irrevocable choice. This is now considered as too early a selection forced upon the pupil. And also, the specialized physics, chemistry, biology courses offered to the science stream are essentially a preparation for further education in science. These courses emphasize the learning of theory. This deprives the pupils of the opportunity of looking at science in its totality as a highly intellectual, problem-solving human activity. It narrows down the view of science and confines

it to the boundaries of the disciplines. Since a majority of pupils taking the separate sciences would not continue their further education in science, it is worthless knowledge for them. These are only a few of the considerations that have led to the idea of developing an integrated science course for IX-X grades replacing the present physics, chemistry, biology courses.

As a first step, an integrated course is being developed for the science group of pupils only. This course will be a dual purpose course offering education in science to the would-be scientists and education through science to the would-be enlightened citizen of a society aspiring towards a scientific and technological orientation. The major criterion for the course is science relevant to the needs of the learner and the needs of society. The criteria identified are:

a) Science-based problems affecting the environment and society - problems created by the advance of science and technology, e.g. energy, population, pollution, hazards from chemicals, etc.;

b) Problems affecting environment and society that science can help solve, e.g. water-logging and salinity, food production, health, education, etc.; and

c) The basic quantum of theoretical knowledge required for further education in science, e.g. the demands of colleges and universities.

The twin processes of curriculum designing and unit development have been allowed to interact during the development phase. It will be a long and arduous task for the planners and science teachers involved in the project to achieve a design measuring upto the set criteria and purposes. And to achieve the purposes, the teaching strategies would, it has been suggested, employ not just real-life situations but real live situations.

Integrated science for higher secondary non-science pupils

At present, all science education ends at Grade X for the non-science pupils. With the deeper and deeper ramifications of science into the fabric of social and individual life, the present exposure to science is not considered enough. It is now proposed to extend compulsory science to non-science pupils at the XI-XII grades. A curriculum outline has been formulated, the criterion for content selection being the social context of science and the impact of science on the social, political and personal life in Pakistan which are mainly the real-life situations.

Training of science teachers

Primary level

Mass in-service teacher training programmes have been undertaken to orientate the primary teachers in the new curriculum.

Linking science education to life

Science and mathematics form a major element of the in-service training courses of four-week duration. During these courses, the teachers practise the activity approach and the use of the teaching kit. The teachers develop a number of teaching aids of their own at these courses which proved that, if provided continuous support and encouragement, the teachers themselves can develop appropriate materials and methodologies and make maximum use of real-life situations and locally available resources in their science teaching. The pre-service courses for primary teachers have been recently revised to enable the teachers to acquire the role demanded by the new curriculum.

Middle level

The middle grade science teachers are of all sorts. Some are science graduates, majority are non-science with 12 years of schooling and a one-year certificate course in teaching. Few in-service courses are held for these teachers. There is a grave need for establishing a support mechanism for these teachers.

Secondary level

All science teachers at this level posses graduate degree in one of the science disciplines and a professioral teaching degree. A great majority have attended in-service courses in teaching the modernized courses in physics and chemistry.

Higher secondary level

The teachers are holders of masters degrees in science. With no professional education in teaching, they are lecturers, as they are officially categorized, rather than teachers.

Major problems and issues

There has been an awareness on the part of curriculum planners and science educators of the relevance of science content to the needs of the pupils and the needs of society. The criterion of relevance leads directly to the linking of all science teaching to real-life situations. This has required the development and adoption of new teaching strategies. In the process of implementing this ideal, problems have cropped up all around, in all aspects of educational activity.

Curriculum development

Textbooks developed by the Textbook Board authors sometimes do not reflect the real spirit of the curriculum and often go beyond the scope of the outlined content using more theory than real-life situations and problems. A further integration of the curriculum development process has to be achieved so that the development of pupils' texts and other curriculum materials is an integral part of the developmental process.

Continuous support for the classroom teacher

The teachers do very well at their in-service training but when they return to their classrooms, they often return to their old methods. When asked to explain, they complain about the attitudes of the heads and the supervisors who still expect the teachers to come up to their traditional norms of disciplined chalk-and-talk classroom practice.

The supervisors and the heads were then called in for orientation and required to change their expectations of the classroom scene. But after the training, they also seemed to return to their old supervisory practices. They complained of the load of office routine and very little time for supervision.

A break through this vicious circle is being achieved in one of the provinces where the job description of the supervisor is being amended to require him to work with the teachers in their classrooms four out of the six working days. The strategem will hopefully be followed by the other provinces.

Alienation of the teacher training institutions

Innovative ideas in education are expected to spring from the teachers' colleges for they are the prime disseminators of pedagogic skills and the first evaluators of the worth of curriculum designs and materials. Unfortunately, however, with the establishment of the Curriculum Bureaus, the teacher training institutions seemed to be left out of the mainstream of educational development activity. The courses for teacher education are often revised only long after a major innovation has been infused into the system. This has resulted in professionally trained teachers pouring into the system still requiring in-service training in the use of the new materials and methods.

A new organizational model in one of the provinces has the potential of eliminating this problem. All the teacher training institutions for primary and middle level teachers have come under the administrative and academic control of the provincial Curriculum Bureau. The instructors of these institutions, in addition to their pre-service teaching, conduct in-service training programmes for primary teachers. This has established fruitful inter-relationship between pre- and in-service training and provides useful feedback on problems, constraints and innovative ideas to the institutions and the Curriculum Bureau. This organizational model is being studied by the other provinces.

Establishment of effective follow-up mechanisms

What happens to an innovation when it finally filters down to the classrooms is the most important piece of information for continuing and maintaining the pace of educational improvement. The organizational dichotomy between the curriculum planning agency

and the implementing agency often hampers the channelling of this essential feedback. The Curriculum Bureaus plan and develop the innovations. The School Directorates with their hierarchy of administrators, supervisors and the classroom teachers are the implementors.

If the teachers are not properly supported by their supervisors in acquiring their new roles and the supervisors not encouraged by administrators to collect relevant feedback and channel it to the Bureaus, the innovation very soon gets adapted to the traditional scene and loses all identity and effectiveness. The following alternate strategies are now being employed to establish an effective feedback mechanism:

a) Intensive training of supervisors in laboratory situations in selected demonstration schools. They will be required to train their colleagues in similar situations in their regions;

b) Legally instituted changes in the job description of supervisors;

c) Establishment of Decentralized Resource Centres and Satellite Resource Centres in the regional teacher training institutions for providing effective communication of materials and ideas to the teachers and gaining feedback from the schools; and

d) Greater collaboration between Institutes of Education and Research, Teachers Colleges and Curriculum Bureaus in curriculum development activity.

Linking science education to real life

Science is meaningful and interesting to learn when it utilizes the real-life situations to promote the understanding of concepts. Science is not just abstract philosophising. The major findings and discoveries of science have been the result of man's intellectual interaction with his environment. Provision of maximum opportunities for interaction with the real-life situations has been the main guideline in developing the activities described in the teachers guidebooks for primary science. The following is an illustration:

Grade III

Topic: Soil

Concept: Soil is composed of pebbles, sand, clay and humus

The unit begins with looking around at the soil by the pupils, making very general observations. The observations crystallize into a specific question: Why do plants grow more profusely at some places than at others? A further discussion leads to the question: Is it because of the differences in soil? Let us find out.

Activity 1. The pupils collect soil sample from just one place. Mix it with water. Study and become familiar with the components - pebbles, sand, clay and humus.

Activity 2. Is there a difference between soils at different places? Pupils collect samples from different places. Find that the quantity of humus differs in different samples. Conclude that humus is important for plant growth.

The sequence continues in the succeeding grades with further questions like: How do winds affect the soil? How does water affect the soil? How can we prevent soil from erosion?

This is only one example. The primary science teachers guides utilize this approach for the building up of all concepts included in the curriculum.

In a mainly agricultural economy, the units link science to real-life situations and provide useful skills relevant to the needs of the community.

At the middle stage, the science curriculum makes use of real-life situations in developing the concepts. The teachers however need to be supported and encouraged in applying the approach to their daily teaching.

The physics, chemistry and biology curricula at the secondary level utilize the real-life problems and situations as exemplars. Now a full-blown strategy needs to be developed to relate teaching to real-life situations.

REPUBLIC OF KOREA

Introduction

The National Workshop was held under the joint auspices of the Science Education Centre, Seoul National Unviersity, and Korean National Commission for Unesco from 18 to 25 August 1980. Twenty-five participants representing every field of education (as extensively as possible) attended the Workshop.

Before the Workshop, a working committee for 'development of modules linking science to real-life experiences' for use in extra-curricular activities was organized. This committee developed three modules on the topics of 'Clean Water', 'Heat and Everyday Life', and 'Electrical Energy'. Two preliminary editions were printed and the modules were tried out at two pilot schools.

The objectives of the National Workshop were set up on the lines suggested by the Preparatory Group Meeting held during May 1980 at Bangkok.

Linking science education to life

The salient features of the National Workshop were: keynote speeches linked with the Workshop theme; plenary sessions for discussion of the problems raised in the report of the Preparatory Group Meeting; visits to pilot schools; and group sessions for formulating guidelines.

The following conclusions were reached:

1. Science education should be strengthened at all levels of education for coping with the present and future national needs. Basic philosophy and methods of science education for the future should be developed on the basis of the current curriculum.

2. Practical issues faced by mankind (environmental problems, food, energy, etc.) should be introduced in science curricula. Science teaching can be made more effective by introducing problems related to students' daily life at each stage.

3. The 'self-learning module' approach is considered as the best method to relate science education with real-life experiences. Modules should be developed to cover various topics to serve as supplementary and reinforcement material. Modules can be used in regular classes but they are more desirable for extra curricular activities.

4. Science learning can be extended and reinforced by utilization of local resources, both human and material, by the teachers.

5. Current pre-service and in-service teacher training programmes should be modified in order to equip teachers with the skills necessary to utilize the modular approach related to real-life experiences.

6. As there is already a practical work component (industrial arts) in the school curricula related to productive skills, science education should continue to be discipline centred. However, teachers should be reminded of the fact that scientific abilities fostered by science education and productive skills are closely related as science offers the theoretical foundations of productive skills.

7. Low-cost equipments should be developed and made available to classroom teachers. There is a need for collaboration among countries in the Asian region in developing, manufacturing and disseminating literature on low-cost equipments.

In the light of the above conclusions, the following recommendations were made by the workshop participants.

1. The philosophy and approaches of science education related to real-life experiences should be further researched by curriculum workers, teacher educators and teachers, and the developmental tasks for the various modules should be developed.

2. In helping students gain productive skills in schools, the traditional thinking of limiting teaching-learning to a fixed

subject should be discarded. An integrated approach is more effective in achieving an educational objective than the separate subjects approach.

3. Low-cost equipments should be designed by curriculum developers and textbook writers. The administrative support to manufacture such equipments should be strengthened. Co-operative system for production and utilization of low-cost equipments should be explored in Asia at the regional level.

4. Teachers must be encouraged to adopt creative ideas in teaching science in relation to real-life experiences and productive skills by utilizing materials and human resources available within the community.

The general structure of science education

School Level	Years of Schooling (Grades)	Periods/ week	Nature of Courses	Status	Comments
Primary	6 (1st-6th)	2-4	Integrated science	Requirement	
Middle	3 (7th-9th)	3-4	Combined science	Requirement	Two teachers teach physical science and biological science parts separately
High	3 (10th-12th)	5-6			
a) Science			Separate sciences: physics, chemistry, biology, earth science	Requirement	All four fields
b) Humanities				Elective (two of four fields)	Actually offering one of four fields as an elective
c) Vocational					
College	2-4	1-3	General science		Offered as general education mostly as history of natural sciences

Linking science education to life

Innovative efforts to develop science and technology curriculum related to real-life situations

Science curriculum revision at the primary school level

Since 1979, the revision has been undertaken by the Korean Educational Development Institute (KEDI) which has been authorized by the Ministry of Education to develop, not only the curricula including science, but also instructional materials such as textbooks and teacher's guides for the primary school level.

New science curriculum reflects social needs and social impacts created by rapid industrialization, such as dehumanization and pollution.

The new science curriculum places more emphasis on real-life situations or problems as well as on the affective domain than the present one.

The objectives and content proposed by KEDI are as follows:

1. Educational objectives

General goals of science teaching are to enhance the development of creative and scientific thinking in children, and to facilitate the development of their positive self-concepts and attitudes toward science and science learning. More specific objectives have been formulated as follows:

After completing the new science programme, children will be able to:

a) manipulate objects and dynamic systems in ways which identify them;

b) identify relationships among objects being dealt with or among variables or factors which influence the dynamic system;

c) manipulate objects and events in scientific ways such as observing, classifying, measuring, using time and space relationships,inferring, conducting experiments, collecting data and interpreting them;

d) recognize scientific knowledge and its application as a man-made tool to solve real-life problems; and

e) recognize the correctness and clearness of the statement or description of scientific knowledge as an important aspect of science.

2. Units of activities related to real-life situations

Grades	Contents or units of activities	Comments
I	a. magnets b. material objects c. living things d. stars in the sky e. What makes sound? (string telephones)	a. Activities are designed to have children manipulate materials first of all, and then discuss what they observe, feel and think about.
II	a. magnets and compass b. balance c. light and shadows d. weather e. growth of seeds f. insects	b. Most of the materials which are expected to be used are chosen from real-life environment.
III	a. batteries and bulbs b. measuring c. soils and rocks d. growth of bean seeds e. growth of frogs and silk worms	
IV	a. structure of plants b. environment of living things c. electric circuits d. rocks and minerals	
V	a. How do plants make food? (photosynthesis) b. small living things c. force and simple machine d. ecosystem (food-web)	
VI	a. our environment and pollution b. human body c. energy and its transfer d. seasons and the solar system e. changes in the earth's surface	

Overall picture of present curricula and its proportional linkages with real-life situations

School level	Courses in linkage to real-life experiences	Proportional composition of real-life situations	Comments
Primary school	A. Industrial arts	100%	content consists of practical problems and real-life situations
	B. Science (nature)	approx. 50%	instructional materials come from real-life situations
Middle school	A. Industrial arts for boys	approx. 60%	above 40% of the content is related to principles and theories
	B. Home economics for girls	approx. 60%	" ditto "
	C. Science	approx. 30%	large portion of the content is related to conceptual schemes
High school (science students)	A. Industrial arts (technical skills)	approx. 40%	a large portion of the content is related to theories and principles
	B. Home economics for girls	approx. 60%	" ditto "
	C. Science	less than 10%	some applications are included in physics, chemistry and earth science; sizable amount of biology deals with objects and materials from real-life situations
(humanity students)	Almost same as science students		science subjects are offered as an elective course
(vocational)	A. Various types of industrial arts: technical, agricultural, fishery, business, home economics, etc.	approx. 80%	
	B. Science	less than 10%	the science students use the same textbooks as humanities students

Examples of content/topics in the present science texts which can be related to real-life situations

School level	Grade	Comments
Primary school	II	1. Weather change 2. Living things in pond 3. Growth of plants
	III	1. Batteries and bulbs 2. Life cycle of animals (frog)
	IV	1. Living things and their environment 2. Lenses
	V	1. Population (living things) 2. Weather forecast
	VI	1. Food web 2. Ecosystem and pollution 3. Human body
Middle school	I	1. Various living things 2. Changes in the earth's surface
	II	1. Circulation of water and air, and weather change 2. Nature and human beings (population, pollution, etc.)
	III	1. Energy transfer 2. Chemical change 3. Metabolism

Teacher training

Institutes	Level	Year	Number	Main courses
Junior Teachers Colleges	Primary	2-4	11	Five credits for science subjects Four credits for science teaching methodology
Colleges of Education	Secondary science teachers	4 (B.S.)	11 (Government)	B.S.
		2.5 (M.Ed.)	9 (Private)	Thirty-two credits for general science (physics, chemistry, biology, earth science)

Institutes	Level	Year	Number	Main courses
Colleges of Education (continued)				Sixty credits for major courses (physics major, chemistry major, biology major, earth science major) Sixteen for education (total: 140 credits) M.S. Twenty-six credits
Correspondence College (SNU)	Primary	2-4*	1	Two credits for science Two credits for science teaching methodology
		*within the next 3 years it will be extended to 4 years		

Major problems and issues

The following problems are expected to be faced if a new programme for linking science education to real-life situations and productive skills is designed and used.

Problems	Comments
A. Teacher attitudes	a. The teacher usually tries to teach science and industrial arts as different subject matter which are incorrectly supposed to be irrelevant to each other. So the teacher does not attempt to integrate the two subjects in terms of inter-relationships. b. There is a strong tendency for teachers to neglect practical problems and skills which are relevant to real-life situations. c. Most teachers feel that the new programmes impose a heavy burden on them because of the extra preparation required.

Problems	Comments
B. Teaching techniques	a. Most primary school teachers are unfamiliar with ideas about how to use and manage real-life situations and problems in order to be compatible with a discipline centred curriculum system.
C. Evaluation system	a. The evaluation system, including methodology and attitudes toward evaluation of learning, which have been established to fit the knowledge-oriented curriculum may not agree with the expected outcomes of real-life oriented programmes. b. There seems to be a lack of agreement about what real-life experiences mean and how we determine them as objectively as possible.

THAILAND

Introduction

A National Workshop on Designing and Developing Innovative Science Curriculum and Instructional Materials was first organized in 1979 for the first cycle of the APEID's programme for the development of guidelines for linking science education to real-life experiences and related productive skills. Because of a number of limitations, the 1979 National Workshop confined its scope to the biology curriculum for high school science major students only. In order to make the high school science programme for science majors complete, the 1980 National Workshop was organized at the IPST from 6 to 10 October 1980 with particular reference to the chemistry and physics curriculum at the high school science major level. The objectives for the Workshop were:

1. to exchange ideas and experiences among the participants focusing on the linking of chemistry and physics education at the upper secondary school level to real-life situations.
2. to analyse the existing chemistry and physics curricula at the same level and propose some examples, activities, and concepts that should be included in the curricula to link the content to real-life situations effectively.
3. to identify the local natural resources and qualified personnel that could be utilized for linking chemistry and physics to real-life situations.

Linking science education to life

Thirty experienced persons from various professions and nine resource persons were invited to participate in the Workshop. Most of them came from applied science or technology institutions e.g. Pharmaceutical and Natural Products Research Unit, Office of Food and Drug Administration, Department of Chemical Technology, Department of Industrial Engineering, Department of Sanitation, Food Science Department, Department of Health, Agriculture, Technical Department. The participants made a number of valuable comments and suggestions on science curriculum devleopment and linking science education to real-life situations.

Following is a summary of the Workshop activities:

The participants were informed about the historical background of the work of the IPST and the science activities organized under APEID. This was followed by the presentations made by resource persons concerning the teaching of chemistry and physics in relation to agriculture, public health, industry, energy and environment respectively. The last phase of the Workshop involved the participants in brainstorming discussions to analyse the present curricula and provide suggestions and ideas expected to be useful in the development of chemistry and physics teaching-learning materials linked to real-life situations.

Some of the Workshop outcomes are described later.

Science education structure

Educational system in Thailand is for six years at elementary level, three years at lower secondary level and the other three years at upper secondary level. Science is not taught as a separate subject at the elementary level. It is integrated in the subject called 'Life Experience'. All concepts and activities are linked to the environment and real-life situations.

The lower secondary science is compulsory for all. Students have to study science for four periods a week for three years. Science at this level is integrated science. It uses the problem-approach in developing the science concepts. The curriculum design utilizes three major themes. These are:

a) changes;

b) energy; and

c) environment

Science at this level emphasizes observing and explaining the natural phenomena and the environment. Teaching is done through observation and experimentation activities carried out mostly in the environment, which thus offers considerable scope to link it with real-life situations.

There are two streams of science courses offered to the upper secondary students - Physical - Biological sciences and the discipline sciences (Chemistry, Biology and Physics). The first course is designed for non-science students and uses the modular approach. Each module is an independent unit. The design also uses the problem-approach as at the lower secondary level. At present, there are fourteen modules and a majority of these are focused on real-life situations. Students have to select at least eight for doing the course. The course emphasises the applications of science to real-life situations.

The separate discipline science course is designed for science major students. These students are supposed to study science further at the university level and hence the emphasis of the courses is on preparing the students for further science education. The course uses the conceptual approach. However, efforts have been made to link the science concepts to real-life situations, mostly by using the real-life situations as illustrations to develop the science concepts.

Innovative efforts to develop science and technology education linked to real-life situations

The Institute for the Promotion of Teaching Science and Technology (IPST) is responsible for developing all science and mathematics curricula for the schools. It is the IPST philosophy that all science courses developed by the institute have to be relevant to everyday life and the real-life situations.

Since the establishment of IPST, several innovative science curricula have been developed and implemented. Some are currently being developed and some are in process of revision after five years of implementation.

The IPST has put most of its efforts in making all science courses relevant to everyday life. This can be seen from the approach used in their curriculum development process. All science courses, except science for high school science major students, are based on the problem-approach. Although science for high school major students are conceptual, the IPST has put in its efforts to link the concepts to real-life situations as well. This is evident from the objectives of the National Workshop stated earlier.

Example of content/topics linking science education to real-life situations

The IPST had put in a great deal of effort in linking, as much as possible, the 1975 chemistry and physics curricula to real-life situations. However, due to several limitations, the 1975 chemistry and physics curricula still did not fully utilize the real-life situations. It was one of the major purposes of the National Workshop to search for appropriate strategies to revise these curricula to link them more closely with the real-life situations. Some of the topics identified at the Workshop that can be used to establish closer links with real-life situations are as follows:

Existing topics in the syllabus	Real-life situations to which the topics can be linked
1. Rate of chemical reactions	- the optimum temperature used in food preparations - the papain from papaya sap is used to accelerate the decomposing of protein in fish-sauce processing and also used as meat tenderizer - C_2H_2 is used to ripen the fruits - CaC_2 is used to accelerate the flowering of pineapple - some antioxidants added to vegetable oil to prevent rancidity - benzoate salts are added to canned food as preservatives
2. Acids and Bases	- acid-base activities in digestive system - soil, water and fruit drinks in everyday life could be used as the sample in studying of pH scale. - buffer action in human and animal body and in plants - buffer action of sea-water or soil - effects of chemical fertilizers on soil - adding of CaO to the low-pH (acidic) soil
3. Organic Chemistry	- fermentation of bio-gas - occurence and utilization of natural gas in the gulf of Thailand - fermentation of vinegar and alcohol from agricultural products - production and use of essential oils - drugs extracted from plants, e.g. Ravelfia Serpentin, Catharenthies rocus

Existing topics in the syllabus	Real-life situations to which the topics can be linked
3. Organic Chemistry (continued)	- medical herbs that can be used instantly, e.g. Pumicagranutum linn (fruit peel) for cure of diarrhoea, Coceimia indica (leaf, root) for inflammation, Cassia alala linn as purgative
4. Industrial Chemistry and Environment	- petrochemical industry and pollution - production of detergent, soap and some cosmetics - problems and hazards of plastics e.g. PVC releases hydrogen chloride gas when it is burnt - causes of water, air and soil pollution - insecticide, pesticide and herbicide - awareness of the harmful consequences of using some medicines
5. Mass, Force and Motion	- equipment used in surveying, e.g. theodolite - the speedometer in the car and motorcycle - examples of work that need accurate measurement and approximate measurement e.g. engine-making, dress-making - pile driver and local pile driver - lever, wheel and axle used in carrying water from deep wells in rural areas - conveyer belt used in factories - water spray of the fire engine used to illustrate the projectile motion
6. Work and Energy	- energy from petroleum, sunlight, water-fall, sea, wind, geothermal - utilization of energy should emphasize on economization and its consequences to social life - calculations of electricity costs of different home appliances, e.g. electric cooker, heater, iron, fan, boiler, TV, radio - safety in use of LPG for cooking - nuclear energy - thermal values of different fuels

Existing topics in the syllabus	Real-life situations to which the topics can be linked
7. Electricity and Magnetism	- solar cell - fundamentals of the household electrical appliances - safety, use and conservation of electrical energy - monorail and seismograph - three-phase power lines and single-phase power lines
8. Waves	- echo problems in the buildings - ultrasonic uses in hospital and industry - fiber optics that physicians use - radio, and TV communications

As it has been stated, the science courses for non-science high school students and lower secondary school science courses are very much linked to real-life situations and problems. To have some perspective of how much this has been achieved, some selected extracts from the syllabus for which modules have been developed are presented below:

Good living World population. Population of Thailand. Population growth and food problems. Food substance requirement for the body. Sugar, starch and cellulose. Role of carbohydrate in the body. Fat, fatty acid, role of fat in the body. Proteins, vitamins, water and minerals. Proportion of food substances as required by the body. Changes of food. Food preservation. Micro-organisms in food production. Food flavouring substances. Poisonous substances in food.

Colour and light Colour of sunlight. Path of light through transparent objects. Formation of rainbow. Combination of colour lights. Path of light through lenses. Image formed by lenses. Camera. Light in photography. Light and chemical reaction. Photographs. Prints using blue-print paper. Slide projector. Eyes and seeing. Characteristics of eyes. Seeing pictures. Short sight, long sight and their corrections. Seeing illusions.

Electricity and appliances Electricity production in Thailand. Hydro-electricity. Thermo-electricity. Fundamentals of electricity concerning electron theory. Electrical potential difference. Electrical resistance. Generators. Simple electrical cells. Lead storage cell. Solar cell or fuel cell. Dynamo. Electric energy transmission. Transformer. Measuring electrical energy. Home electricity. Fuse. Circuit. Switch. Plug. Utilization of electricity. Electric bulb and luminescent lamp. Electric appliances. Safety in using electricity.

Invisible rays Wave-like rays. Ultraviolet rays. X-rays. Gamma rays. Infrared rays. Sources, properties and usefulness of these rays in daily life. Transmission of sound by radio waves. Simple radio receiver. Telephoto. Television. Micro-waves and rad r system. Telecommunication satellite. Telecommunication by Teletype, telephone, telephoto, telecast through satellite. Telecommunication between Thailand and other countries.

Synthetic substances Natural and artificial substances. Human needs. Synthetic process. Synthetic substances. Plastic synthesis. Initial materials for plastic synthesis. Types of plastics. Production of plastic utensils. Plastic utilization forecast. Plastic utilization and environment. Synthetic textile and production. Textile utilization. Quality of textile. Clothes and stains. Science and washing. Soap. Detergents. Detergents and environment. Future roles of synthetic substances.

Natural resources and industry Meaning of natural resources and industry. Some sources of important natural resources in Thailand. Production quantities and export. Utilization of the natural resources in industry. Standard of products. Industrial problems and their solution. Trends in utilization and conservation of natural resources.

Medicine and life Diseases and their causes. Meaning of medicine. Use of medicine to cure illnesses. Herbs. Antibiotics. Synthetic medicines. Dangerous medicines. Trends in the use of medicine. New technology for curing and diagnosis. Poisonous substances used in prevention and elimination of disease carriers and pest control. Effects of medicine and poisonous materials on the environment.

Teacher training programme

It is realized that development of improved curricula and new instructional materials alone is not enough to promote changes in teaching and learning science in schools. Effective teacher training programmes are also needed and therefore an in-service programme was carried out by IPST for training teachers to be ready to teach the new science curriculum materials.

The in-service training programme has been developed for three main purposes: (i) to ensure that teachers have a sympathetic attitude to the new teaching approach; (ii) to ensure that teachers understand the subject matter; (iii) to ensure that teachers know how to use the new materials including the visual aids and new laboratory equipment.

As part of the teacher in-service training programme, IPST has adopted an approach which integrates content with method. Instructurs use the methodologies that they would like to see teachers use in their classroom. Teachers during much of the in-service training act as high school students, while instructors act as high

school teachers. With this technique, teachers were expected to learn the methodologies in relation to the content to be taught rather than in isolation. However, a few special lectures on content, teaching techniques, and evaluation techniques are offered. In addition to these, teachers also have an opportunity: (i) to perform all experiments which they would have to manage in the classroom, (ii) to observe and use video-tape, audio slide-tape, audio-filmstrip and programmed instruction booklets about the classroom management of experiments, laboratory safety, etc., and (iii) to discuss the IPST philosophy and objectives of science teaching, together with its evaluation. The IPST, with strong support from the Ministry of Education, organized the in-service programme for high school science teachers at the institute itself. However, for the training of the large number of lower secondary school science teachers, the IPST and the teachers' colleges all over the country joined hands to conduct the training programmes. Instructors of the teachers' colleges were recruited to receive training at the IPST and worked as instructors at training programmes held at their own institutes. The training programme for instructors also provided guidelines for the pre-service training programme conducted in their colleges. By using this multiplier technique, almost all teachers were prepared to teach the new materials which were introduced in the higher secondary schools in 1976 and in the lower secondary schools in 1977 respectively.

The training programmes are considered as a continuous process. Information obtained from the follow-up programme indicated many short-comings needed to be overcome in the use of the new curriculum such as lack of some audio-visual aids and problems of repair and maintenance of school science equipment. This led to the establishment of the Science and Technology Teacher Servicing Centres (STSC) in teachers' colleges all over the country. The STSCs collect information from schools in their responsible areas and provide assistance and support. The activities carried out at these centres are mainly training programmes geared to particular needs and requests made by teachers.

Simple science equipment

IPST is responsible for the development and implementation of science curriculum. The curriculum implemented in 1976 was developed in the so called problem-approach style. The learners are supposed to perform experiments to collect data and draw conclusions. The IPST, therefore, is also responsible for designing the simple and low-cost equipment required in teaching each science curriculum. The simple equipment designed by IPST include more than 200 items. Some examples are included in Annex III.

Major problems and issues

Three major problems are identified in the development and implementation of the curriculum materials linked to real-life situations. These are: problems concerned with teacher-training programmes; availability of needed equipment; and social acceptance.

The teaching abilities of science teachers is a crucial issue. Teaching science for everyday life requires well trained teachers with not only the competence in teaching and a good background of the subject matter, but also knowledge and understanding of real-life situations and the ability to use them in their teaching and to apply the concepts and principles to the learner's everyday life. Effective teacher training programmes have to be designed for providing these new skills and competencies.

The second issue is the provision of the required science equipment. Although local materials used in teaching-learning science linked to real-life situations can be obtained in the school surroundings, some manufactured items of science equipment are inevitably needed in every school for use at every level. A number of schools, particularly the small ones located in rural areas, will be faced with the problem of equipment shortage due to lack of budget. The use of teacher and student made simple science equipment will have to be encouraged, which again needs training and production of instructional manuals.

The third issue is the question whether the programme will receive general acceptance. People prefer to see science teaching in schools as subject-matter oriented since they want their children to go to the universities. Further attempts might have to be made in convincing parents, pupils and other concerned people to understand and accept the programme.

Chapter III

SYNTHESIS OF EXPERIENCES OF NATIONAL WORKSHOPS

1. Reactions to the proposal for relating science education to real-life situations and productive skills

At all the national workshops, the idea of relating science education to real-life situations and productive skills was well received by the participants who were heterogeneous groups of teachers, teacher educators, science curriculum and equipment developers and experts from varied fields of applied sciences. Some concern was however voiced about the general acceptance of the proposed approaches to science teaching, accustomed as people are to the traditional styles of content and methods of delivery.

2. The present situation

There has been an awareness among teachers, educators and curriculum planners of the need to relate science to real-life situations and even the present curricula in some areas of science attempt to relate science to everyday experience, but a specifically directed conscious effort to orient teaching-learning towards that end has seldom been undertaken.

Analyses of science curricula at various levels of schooling have identified broad areas where science content can be meaningfully related to the local environment and societal needs.

3. Two alternative strategies for relating science education to real-life situations

In order to base curricula and classroom practice on real-life situations, complete break with traditional content and approaches was found not advisable in most countries on grounds of feasibility and costs. Gradual revision of curricula, relating further areas to real-life situations and creating materials and support systems for teachers to help them change their teaching styles, was the acceptable mode for infusing the innovation. However, while embarking upon fresh curriculum projects, a start could be made with an assessment of the science related problems affecting the environment and society and of the real-life situations. From such as assessment, a whole science programme could emerge which measures up to the criterion of relevance to real-life situations and provides the productive skills needed for well-balanced growth and

development of communities. In such an approach real-life situations, which are by their very nature complex, will have to be identified and analysed for potential science content.

4. Curriculum development potential

Most countries in the region have well established curriculum development institutions with the potential and capabilities to employ the gradual renovation and materials development strategy or to develop entirely new curriculum designs fully based upon real-life situations.

5. Preparing teachers to use real-life situations - multiple strategies for training, feedback and evaluation

Effective dissemination of change however poses problems to a majority of countries in the region. Affecting classroom practice in the large number of schools spread far and wide in an area is stupendous task for many countries. A variety of strategies are being employed for in-service training of teachers to make them familiar with the new approaches to teaching science. The downward filteration through master trainers is the most popular strategy for reaching the large number of teachers.

The teachers colleges have been used as venues for the conduct of in-service training programmes and their instructors have been employed as master trainers. This association of the teachers colleges with the curriculum developers has benefited the pre-service training as well and resulted in quick feedback of teacher opinion to the innovators.

A dilution effect has however been noted on large scale employment of this strategy. Alternative strategies establishing direct contact and continuous support systems are being developed and used in some countries. The Decentralized Resource Centres and Teacher Servicing Centres are examples of this strategy. Yet another alternative is the strengthening of the existing supervisory systems to provide a continuous professional support for science teaching. In many of the educational administrative set-ups, the supervisors are the main channel of contact with the schools. They can, if properly groomed and supported in their tasks, play a vital role not only in effective implementation of innovation but also in providing the feedback that is so essential for evaluation and removal of constraints and bottlenecks to keep the innovation alive and healthy, and maintain continuous and sustained progress.

6. Teachers' colleges regain the mainstream of change

Another problem with teacher training has been the pouring into the system of freshly trained teachers from the teachers colleges. These professionally trained teachers are however not oriented to the innovation. The curriculum and practices at the teachers colleges have not kept pace with the change. The anomaly

has now been recognized and professional courses are being revised to correspond with the changes. Greater participation of the teachers colleges in curriculum development and conduct of in-service training is being fostered. In some countries Resource Centres and Teacher Servicing Centres are being located in the teachers colleges and their staff utilized for the conduct of the centres' activities.

7. Equipping for change

Production and provision of equipment needed for the adoption of science teaching related to real-life situations has been a major constraint. Feasibility flounders when basic equipment is denied to the schools. A variety of means are employed to meet that end. Teachers called for in-service training are encouraged to make the maximum use of locally available resources in their science teaching and devise their own equipment from low-cost local material. The curriculum centres in some countries develop the prototype equipment, get it mass produced and distributed to the schools. Some countries have established National Equipment Centres for development, manufacture and distribution of equipment. One more type are Audio-Visual Aid Centres that develop prototypes, train the teachers in the use of equipment and maintain a mobile unit for display of educational films, slides, etc., on request from the schools. Some countries have developed teaching kits containing basic equipment and tools that are supplied to the schools. There have been instances where the supplied equipment is not being used by the teachers and not properly stored and maintained. Lack of storage and maintenance facilities and lack of knowledge and skills in the use of the material are often the reasons. This calls for organizing training courses focusing on use, maintenance and repair of equipment, particularly for senior grade teachers where sophisticated equipment is used. Another innovation which has helped in bringing the science teaching more closer to real-life situations is the production and distribution of local specimens and biological materials and their distribution through the Resource Centres.

8. Follow-up, feedback and evaluation

A synthesis of strategies employed for follow-up and feedback has been presented under the earlier section on "Preparing teachers to use real-life situations". Establishing and maintaining effective channels of communication to the schools and teachers has been the object of the mixes of strategies. The association of teachers colleges with curriculum development and dissemination, the strengthening of the existing supervisory systems, the establishment of Resource and Servicing Centres for teachers are mechanisms that can, when fully utilized, serve as follow-up and feedback systems.

Innovative curriculum designs and materials are often tried out in pilot schools or random samples of schools before large scale implementation. But scientific, research based, summative evaluation are seldom undertaken. The requisite research potential is not available to educational systems in some of the countries. In others, the research exercise is considered a luxury in terms of the funds and manpower involved. The need however is felt for developing some tangible mechanisms that can provide answers to some of the important questions troubling the minds of the innovators regarding the innovations' worth and usefulness to the community. This, the innovators need, not only for improving the innovation but also to be able to present solid, research-based evidence to all those who doubt the worth of the enterprise. This could lower the resistance to change and encourage acceptance which is vital for enlisting community support for the innovation.

Chapter IV

LINKING SCIENCE TEACHING/LEARNING TO REAL-LIFE SITUATIONS

The Rationale

All scientific knowledge is the product of man's intellectual inter-action with his environment. All the concepts of science relate to the natural phenomena and changes occurring in the environment. The human environment is the frame of reference for all the theories, principles and facts of science. Bereft of this frame of reference, science loses all meaning and relevance. Unfortunately, however, science curricula and science teaching in the schools have relegated this frame of reference to a secondary position. A rather distorted, less meaningful, uninteresting image of science has thereby replaced the magnificent edifice of human knowledge that is science. In order to give meaning and purpose to science, it is essential that science spring from real-life situations, from where it originally sprang up and came to life. Linking science to real-life situations is not establishing a forced link, rather it is mending up a vital link broken, perhaps accidentally, in the race towards spreading scientific knowledge.

There are a number of other basic considerations which give rise to the idea of linking science education to real-life situations.

1. The need for improving educational relevance

One way to examine educational relevance is to find the answer to the question of how far education can contribute to the national development goals and thus to the development of the society. It is within this context that science education plays a major role in the whole educational process.

The relevance of science education from this sociological point of view is examined in terms of how well it could accelerate the process of development taking place in the society. Besides, it is equally important that science education should provide the student with useful knowledge and experiences which are functional in real-life in society. In order to meet this expectation, there seems to be no better way for science education than to relate its curriculum to real-life situations.

2. The need for improving educational effectiveness

In order to maximize the attainment of objectives in science education, educators should take into account the psychological aspects of the learners in designing the curriculum. Or, stated another way, science education programmes should be developed on the basis of learning theories taking into consideration both the pupils' cognitive development and their interests.

Linking science curriculum to real-life situations would enable the students to start their learning with concrete situations and to actively engage in the learning process which would further develop their interests in learning. Linking school science to real-life situations provides maximum opportunities to the pupils for interaction with the environment. And all learning theories stress that interaction promotes not only learning but also helps develop the abilities required for learning. Depriving children the opportunities to interact with the environment can often result in mental and physical deprivation. Fostering balanced physical and mental growth of the child is the prime objective of all education. Linking science to real-life situations therefore would increase the opportunity for the pupils to attain the desired objectives which also means to increase the effectiveness of science education.

3. The need for improving educational efficiency

Education is meant to develop not only the cognitive aspect of the individual but also the psychomotor and affective aspects as well.

To increase the efficiency of educational process, one needs to find an instructional strategy which would enable the pupils to develop all the three aspects of their behaviour (cognitive - psychomotor - affective) simultaneously. By linking science curriculum to real-life situations using available resources from local environment, it is expected that pupils would develop not only cognitive skills but also psychomotor as well as affective behaviour in an efficient manner.

Besides the afore-mentioned advantage, linking science education to real-life situations would also make science education more meaningful in terms of both the outcomes and processes.

Curriculum design considerations

With a view to design an innovative science curriculum linked to real-life situations, besides the usual considerations for curriculum design e.g., those of the developmental stages in children and of the national educational goals etc., the following specific considerations should also be kept in mind:

1. Designers: It is suggested that persons from all walks of life, especially those who are in active association with applied science and technology e.g., agriculture, industry, environment and sanitation etc., should be involved as part-time or whole time members in the curriculum design committee in addition to science educators, teacher educators, educational psychologists, scientists and teachers.

2. Flexibility in the curriculum design: Linking of science curriculum to real-life situations should be based on locally available resources. In other words, curriculum should be so flexible as to allow the teachers to enjoy at least some degree of freedom in matters of selection of locally existing resources, thus facilitating the implementation of a centralized curriculum.

3. Designing approach: Two possible approaches for designing science curriculum linked to real-life situations are suggested:

a) to identify the real-life situations and link these to the appropriate concepts in the existing curriculum. This would lead to enriching of the curriculum through the inputs from real-life situations at appropriate entry points. In this strategy, the basic structure and design of the existing curriculum would remain unaltered, and yet large number of linkages with real-life situations would have been established. This alternative could be the first step towards the gradual development of a science curriculum fully based on real-life situations.

b) to survey and select real-life situations or problems suitable for specific grades and to develop the curriculum with real-life situations or problems as the starting point. Science concepts relating to real-life situation and problems would thus form the curriculum content.

It is felt that ideally, this approach is the most suited for development of science curricula linked to real-life situations. However, given the present conditions, the first approach can be adopted as an intermediate step towards achieving the ultimate goal. All future attempts at developing new science curricula should however increasingly adopt the second strategy.

4. Curriculum materials: Curriculum materials should be so designed as to help the teachers and pupils in the achievement of clearly defined objectives related to the scientific understanding of real-life situations and problems. Evaluation procedures and practices should be designed to test the attainment of the set objectives rather than requiring recall of facts and theories. Some examples of objectives are given as follows:

The student should be able to:

a) keep himself and his environment clean;

b) realize the harmful effects of pollution and suggest ways to prevent it;

c) select healthy food;

d) participate in improving food production in his own area;

e) participate in efforts to protect and preserve the natural environment; and

f) make use of simple machines in doing manual work.

Maximum utilisation of locally available resources and low-cost equipment should be ensured while designing the curriculum materials linked to real-life situations.

Curriculum development considerations

Certain definite processes are always employed in the task of curriculum development or renovation. The concern here is to point out the stages of the process where particular strategies will need to be adopted in linking science curriculum to real-life situations and development of productive skills.

1. Survey of real-life situations. In order to link science to real-life situations, a first step could be to make an assessment of the science related situations and problems existing in the community. This can be done through a mix of the following:

a) interviews with community people;

b) eliciting the opinions of experts such as doctors, building and drainage engineers, experts from water, gas, electricity supply departments, agriculturists, drugs control, population, health and nutrition and sanitation, industries;

c) seminars, workshops of experts, teachers and curriculum planners;

d) field survey of the local environment. The survey team could include ecologists, biologists, geologists and other scientists along with teachers and planners;

e) study of literature on local environment and community problems;

f) study of national priorities for economic progress; and

g) study of national development projects.

2. Identification of the needs of pupils, individual citizens, community and nation

Based on the survey of the real-life situations and problems the needs can be identified. By needs we mean what the pupils need to know, what skills they need to acquire and what attitudes they need to adopt. The needs can be classified into:

a) the present needs of the pupils at a specific level for balanced physical and mental growth and their adjustment with the immediate environment;

b) the future needs of the pupils as responsible individuals;

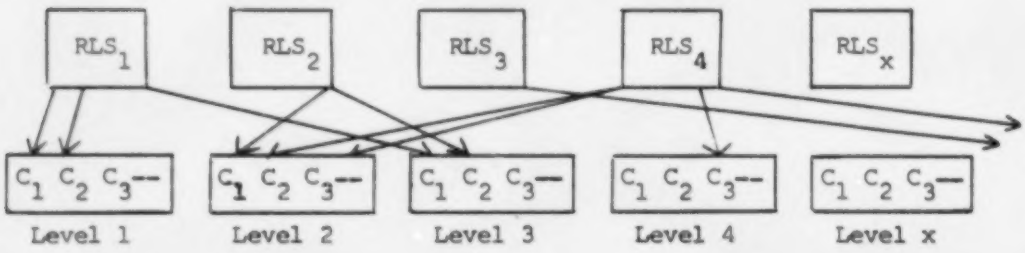
c) the needs of the community for responsible and productive members of the society possessing positive atittudes.

The needs of children and adults in a society are always related to the physical and social environment. The identification of real-life situation and problems will lead to assessment of specific needs.

3. Selection of content linking science to real-life situations and development of productive skills

Two alternate strategies for this purpose are suggested:

a) to select from the list of identified real-life situations and link these to the already existing science curriculum content. The process is represented in the following diagram:

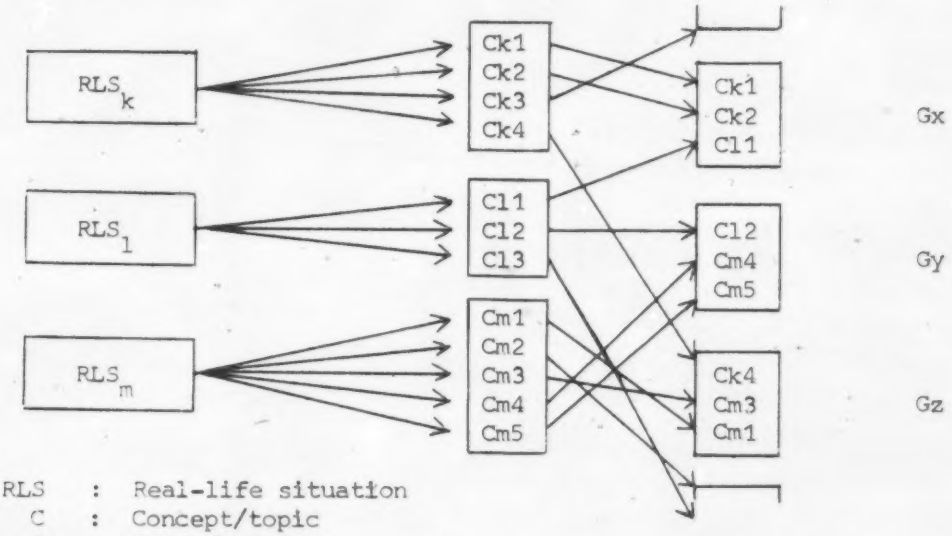


RLS : Real-life situation
C : Concept/topic in existing curricula

It can be seen from the diagram that certain real-life situations may not be linked with a certain lower level of curriculum but can be linked to a higher level. And also some of the concepts in the existing curriculum may not find a link with any real-life situation, and vice-versa.

If a certain important real-life situation does not link with any level then it warrants a redesigning of the content to accommodate the situation; for science, if it is to be relevant, must take into account an environmental situation that affects the life of a society.

b) the other strategy suggested is to develop a fresh new curriculum entirely based on the real-life situations and development of productive skills. The identified real-life situations can be analysed for the potential science concepts needed to be acquired for understanding and adjusting with or grappling with each real-life situation. Groups of concepts can then be selected to form the content at each level. The figure below is a diagrammatic representation of the process:



RLS : Real-life situation
C : Concept/topic
G : Grade/level

It can be seen that all the concepts at a certain level spring from different life situations. The whole content would be based on real-life situations. This is not achieved in the first strategy where many of the concepts at a particular level in the existing curriculum may not link to any real-life situation.

In the organization of the content selected through this second strategy, any of the available models can be used. The content at any particular level could form a grouping of concepts, topics, units, themes or modules.

4. Teaching-learning strategies for situations-linked curriculum

The textbooks on pedagogy advise upon sound practice for creation of learning. The real-life based science however needs a greater emphasis on some of the aspects identified below:

a) the classroom teaching should be more and more activity-oriented;

b) environmental situations should invariably be employed in the development of concepts;

c) the problem-solving approach should be used more often;

d) locally available resources, both natural and human, should be exploited to the maximum in the daily teaching;

e) greater amount of time will need to be given to field trips, excursions and environmental projects;

f) in all the activities, the learning of processes should be emphasised and acquiring of productive skills should be encouraged at every opportunity; and

g) in changing to the new styles of teaching, the classroom territory should expand over the whole environment.

5. Curriculum materials

Textbooks, work sheets, lab manuals, supplementary reading materials, teachers guides and such usual paraphernalia for pupils and teachers would obviously be required. But the approach to presentation in each of these items would have to change utilising real-life situations as the basic content. For the existing curricula, supplementary material can be produced linking the content to real-life situations.

6. Equipment

When the textbooks and teachers guides are developed and activities detailed out, a fresh inventory would have to be drawn of equipment needed for exploration, investigation and experimentation in the environment and real-life situations. Some of the required items would be the traditional science equipment, but quite a few new items would have to be developed, mass produced and supplied to the schools.

The teachers would need to be encouraged to develop their own teaching aids utilizing the locally available materials and improvizing even for conventional apparatus from locally available resources.

7. Try-out

In developing and implementing any new scheme, a try-out is essential. Here the try-out should test the relevance of the content to the real-life situations, the grading of the real-life related science concepts for the different levels, and the feasibility of the new teaching style in relation to time, training and cultural constraints.

8. Finalization

Final revision of curriculum, content and materials should be made after due consultation and involvement of practicing teachers, planners and experts from the different fields.

Implementation considerations

Regarding the implementation of new programmes linking science teaching/learning to real-life situations, the following aspects should be taken into consideration:

1. Teachers

The teachers role is vital for the successful implementation of new science curricula related to real-life problems or situations. The new science programme would, however, require some specific competencies and attitudes such as:

a) sensitivity to the curiosity and responses of pupils to real-life situations;

b) ability to identify relevant science content from events and activities in the environment and relate them to classroom activities;

c) ability to utilize real-life situations as spring board for introducing science and technology content;

d) ability to identify and use local resources, human and material for instructional purposes and project implementation;

e) skills in conducting out-of-classroom activities such as field trips, field studies and community-related projects;

f) sufficient knowledge of the immediate natural environment and community of the child;

g) ability to integrate learning of science with other disciplines; and

h) skills and ability in designing and constructing low-cost equipments and aids for instruction,using locally available materials.

2. Supervision system

Well motivated, qualified and co-operative school supervisors have an important role to play in successful implementation of any new educational programme and more so for the ones which attempt to link science education to real-life situations. Experience shows that the supervisory systems are not yet fully geared to take on the task. Therefore, in order to effectively implement new science programme, the supervisors and supervision system should be taken into account in terms of the following:

a) Qualifications of school supervisors

Supervisors should be:

i) qualified, experienced former school teachers;

ii) capable of giving effective demonstration lessons related to real-life problems;

iii) familiar with science curricula, especially their educational objectives; and

iv) familiar with local conditions, needs and resources.

b) Duties of school supervisors

Supervisors' duties should include:

i) helping the teacher to do a better job; and

ii) giving guidance and advise to ensure that learning objectives are achieved in terms of understanding of real-life problems or situations.

c) Support services

The supervisors need the following support services:

i) clerical and professional support. The supervisors should spend most of the working week visiting schools; and

ii) sufficient budget to meet travel expenses in organizing teachers courses and for purchase or development of exemplar equipment items linked to real-life problems or situations.

d) Utilization of resource persons as supervisors

If the number of supervisors is limited, the following resource persons can be utilized:

i) college professors from universities which are located in that particular area or nearby areas;

ii) science qualified head masters or teachers from school clusters; and

iii) science education specialists from related organizations and agencies.

3. Administrative support system

There have been many failures in implementation of new science programmes because administrative procedures, rules and requirement are not supportive of new science teaching-learning methods. Attempts should be made to alter and ameliorate this situation so that necessary support for active and successful implementation is forthcoming from the administrative system. The following administrative support is considered most valuable:

a) The school principal/head should have at his or her disposal sufficient funds to support science teaching in and out-of-school, including visits, science fairs and science competitions particularly to enhance the relevance of science teaching;

b) The school principal should have clearly defined administrative and educational responsibilities to carry out implementation of new programme in the school.

c) Each school should have approach to at least one science adviser who should be able to provide guidance on science teaching and the management of resources. This is particularly needed at primary level. The adviser can be a science qualified supervisor, teachers college instructor or any other capable and approchable person.

d) Principals/heads of schools should have thorough orientation in the demands of implementing the change.

e) A flexible approach to time tabling and fixing of vacations is necessary, especially in rural areas.

f) Financial arrangement, if necessary, for teacher preparation in the new science teaching linking it to real-life experiences and production of low-cost equipment should be considered. At the secondary and upper secondary levels clerical assistance should be available to the science teachers to keep them free from official routine.

4. Evaluation system

Most of the participating member countries feel that new evaluation techniques and examination system should be developed which are compatible with new science programmes, especially for linking them to real-life situations or problems. It is also felt that the demands imposed by the existing evaluation methods and entrance examinations will have the effect of degenerating the goals of new real-life linked science curricula into knowledge-bound programmes. It is, therefore, essential that evaluation techniques and examination systems compatible with the objectives of the new programmes be developed.

Evaluation should be based on assessment of student performances in science learning including attitudinal changes, acquiring of productive skills, and creative thinking with respect to real-life situations. Evaluation can also employ various techniques for this purpose including interviews with students.

Furthermore, useful school experiences of students and their school records should be considered essential to complements the results of the entrance examination.

5. Supporting centres

Some of the participating countries have already established provincial or local centres to provide support to science teachers in all aspects of teaching. Science and Technology Teacher Servicing Centres in Thailand, Student Science Centres and Local Resource Centres in the Rep. of Korea and Decentralized Resource Centres being developed in Pakistan are examples. It is recognized that these centres are doing a lot of work such as undertaking science teacher retraining programmes, supervising programmes; providing mobile unit services. The centres have a great potential for developing as continuous support system for teachers.

Teacher training

1. Pre-service training

In the existing programmes for pre-service training of science teachers in member countries, the courses on science teaching methods mention the relating of science to real-life situation as a guideline for good science teaching. It is however felt that sufficient emphasis has not been placed on this aspect. The following suggestions for orienting pre-service training of science teachers towards situations-based teaching are proposed.

a) Objectives

Efforts to link science education to real-life situations should be evident first of all in the objectives stated for the teachers training programmes. The following objectives added to the existing list can help orient the programme in the desired direction:

i) to identify real-life situations and related problems that can be linked to science education;

ii) to plan teaching-learning activities to apply science concepts in the understanding of real-life situations;

iii) to plan teaching-learning activities to apply science concepts to solve problems in real-life;

iv) to use the environment as a learning resource;

v) to make science education meaningful by relating it to the environment and the day-to-day experiences of the learners;

vi) to create a positive attitude towards science based on real-life experiences; and

vii) to prepare and conduct evaluation of the process as well as the outcomes of learning linked to real-life situations.

b) Organization of the programme

Sufficient time is not allotted in the pre-service training of primary as well as secondary school teachers to teach the pupil-teachers 'How to teach science'. Most of the time is spent in mastering either the theoretical pedagogical courses or the content of science. It is suggested that a balance between the teaching of science content and the teaching of 'How to teach science' should be achieved while formulating the programme for the pre-service training of teachers for all school levels.

Furthermore, it is suggested that the methods of teaching science should be taught not through lecturing but through demonstration lessons by trainers who have enough background in science and are well acquainted with the various approaches and methods of teaching science.

In addition to the general suggestions mentioned above, opportunities should be provided to the pupil-teachers to acquire abilities and skills to link science education to real-life situations.

The following skills are proposed for inclusion in the training courses for teachers:

i) identifying real-life situations and related problems through literature study or survey;

ii) analysing the science curriculum of various school levels to identify concepts that can be linked to real-life situations;

iii) practice in planning activities to apply science concepts in understanding real-life situations;

iv) practice in planning activities to solve problems in real-life applying scientific knowledge and skills;

v) making simple equipment from locally available materials for the teaching of science;

vi) selecting appropriate techniques of evaluating the outcomes of learning science linked to real-life situations; and

vii) undertaking research projects on some problem aspects of real-life situations in the environment.

In-service

1. Objectives and contents

The objectives of in-service programmes for both primary and secondary teachers to prepare them to teach science curricula related to real-life situations should be directed to the development and improvement of teachers' interests and capabilities for the following:

i) to identify critical and relevant issues in the real-life situations such as pollution, erosion, energy, etc.;

ii) to relate identified issues to the content (topics/units/concepts) of the curriculum;

iii) to specify learning resources and equipment which:

a) are available in the environment; and
b) can be produced by the teachers

iv) to produce simple/low-cost equipment needed for linking science curriculum to real-life situations;

v) to plan and conduct teaching-learning activities using the resources/equipment specified above; and

vi) to prepare and conduct evaluation of the process as well as the outcomes of learning linked to real-life situations.

2. Organization and procedures

It has been widely known that in the conventional in-service programmes instructors tend to spend much of the available time for lectures and 'question-answer' sessions. In conjunction with the idea of linking science curricula to real-life situations, the existing practices of in-service programmes need to be improved and adjusted to the demands of the new approach. The following are suggestions for making in-service programmes better suited to the need for linking science education to real-life situations:

i) prepare and send training materials to the trainees before the actual training programme begins;

ii) use most of the training sessions for activities such as:

   a) surveys of the critical and relevant issues in real-life situations;
   b) group discussions on how to link various issues to the content of the existing curriculum;
   c) practice in the designing and construction of low-cost equipment; and
   d) practice/simulation in how to teach science linked to real-life situation

iii) evaluate the results of training in terms of how far the teachers have shown their capabilities and interests in linking science curricula to real-life situations. Observations on how teachers participate in the discussion, analysis of the products (reports, examples of equipment) made by teachers during the training programmes, are illustrations of the possible ways of evaluation that need to be conducted during and at the end of an in-service training programme.

In addition to the above stated suggestions, it is also important to establish local resource centres equipped with various learning resources for teachers to study. The centres may also be used for discussing ways in which various learning resources are used in the actual teaching-learning activities linked to real-life situations.

Low-cost educational equipment

1. Exploiting the environment for teaching tools

For a long time it has been the general understanding that science teaching demands a specialized classroom laboratory where activities or experiments are done through a contrived situation. Discipline-based laboratory-dependent science education demands more inputs in terms of sophisticated expensive equipment and related materials and therefore poses the almost insurmountable constraint in introducing science education in the schools. However, introduction of science education linked to the real-life situations

will not only be pedagogically sound, make science education relevant to the real-life problems and bridge the gap between science education and the needs of the individual and the community, but at the same time will be within the available financial resources in participating countries. In a science course linked to real-life situations, most of the activities will be based on investigation and experimentation in the environment and few on contrived situations. In such a science course, most of the materials needed for teaching-learning can be derived from the environment and the community resources. The surroundings can be used for scientific investigations and practical work can be designed to acquaint the learners with their environment. For classroom and laboratory activities specimens and materials available in the environment and the community can be utilized. For a number of activities the teachers will be able to improvise their own equipment themselves using locally available materials including unutilized ones, underutilized, and throw-away materials. The community expertise can be made use of in constructing needed equipment. Improvisation of simple equipment by the teachers and students will not only economise the cost on school equipment purchases, but will also help the learners to acquire a view of scientific activities that is meaningful and close to their real-life situations.

2. Teacher made materials and their limitations

Simple low-cost equipment related to the curriculum will have to be produced by the teachers themselves and through teacher-student activity, more so at the primary level. Even then, some essential equipment will have to be provided for both primary and secondary level science which the teachers will not be able to produce themselves. Such equipment will have to be mass-produced. The need for such equipment will be greater at the secondary and higher levels. Again, considering the huge amount of equipment needed for the vast number of schools, it becomes obvious that the equipment improvised by the teachers themselves and through teacher-student activities cannot become the principal source of supply of equipment to the schools.

3. Helping the teachers to improvise

'How to make' instruction sheets should be developed, containing the details of how to make improvised items of equipment, the list of the materials to be used, the design specifications, the assembling techniques and how to use the equipment. These instruction sheets should be made available to the science teachers.

Science exhibitions and science fairs should be organized for display of innovative equipment as a regular feature of science activity and provision for recognition and awards should be made for the best exhibits.

4. Equipment production centres

It is more and more realized that the most productive and least expensive means of producing and providing educational equipment to the schools will be organized design and mass production through the national equipment centre, with production principally done in the private sector and through small-scale cottage industry, and the national equipment centre acting as the co-ordinating and regulating agency in matters of design, development, mass production, quality control and distribution of equipment to schools. Furthermore, it is deemed very important and essential to initiate and establish parallel development of educational equipment by encouraging and motivating the teachers and providing facilities required, to develop their own equipment.

5. Criteria for costs

The criteria for defining an equipment as a low-cost equipment should be in terms of its cost-effectiveness and satisfying the educational requirements. Some of the criteria that should be considered with reference to the design of a low-cost equipment are:

- Relevancy and appropriateness of the equipment to the subject matter
- Materials cost
- Durability
- Simplicity and ease of handling
- Impact of the equipment
- Suitability in the local conditions
- Interchangeability of parts
- Multi-purpose use
- Time-saving in handling and operation
- Safety in operation
- Clarity and visibility.

Chapter V

SUGGESTIONS FOR FOLLOW-UP ACTIVITIES

The Workshop, while endorsing the suggestions made by the first Sub-regional Workshop held in Colombo (December 1979), and taking into account the experiences of the countries participating in the present Workshop, made the following suggestions for follow-up activities at the national and regional levels:

National level

1. Efforts need to be made to involve expertise outside the field of 'education', particularly specialists from areas of applied science and technology, both through institutional and administrative arrangements, to work with science curriculum developers for developing programmes of science education linked to real-life situations.

2. In order to identify real-life situations with a potential science content, surveys at local, district and provincial levels will need to be undertaken through an integrated effort of educational and other agencies.

3. Curriculum Development Centres should undertake the analysis of such real-life situations to specify the linked science content for various levels of school education.

4. Utilizing the vast amount of printed material prepared by other development agencies for health, agriculture, community development, etc., the Curriculum Development Centres, through the involvement of interdisciplinary teams, should develop varieties of instructional materials such as modules, units, supplementary readers on important science contents linked to real-life situations.

5. To encourage the use of environment and developing simple teacher-made science equipment using the locally available materials, training workshops should be organized to design such equipment and prepare 'How to make' instruction sheets.

6. The Curriculum Development Centres should organize workshops to prepare appropriate evaluation tools for evaluating the science learning outcomes, using the real-life situation approach, particularly for the affective and psychomotor domain and the process-skills in science.

Linking science education to life

7. Through appropriate arrangements, a critical review of the science teacher training programmes should be undertaken with a view to propose alternative approaches for preparing science teachers and identifying the new roles, skills and competencies needed by the teachers to increasingly link science teaching/ learning to real-life situations and environment of the learner.

8. The need for continuing in-service training and professional support for the science teachers should be recognized, and for this purpose the present efforts in the form of Decentralized Resource Centres, Teacher Servicing Centres, Student Science Centres, Education Extension Centres, already operating should be expanded and further strengthened.

Regional level

1. As many innovative efforts are being made in the participating countries to increase the relevence of science teaching/ learning and many experiences have been gained which could prove valuable to other countries in the region, APEID should encourage the programme of study visits of science educators to make on-the-spot study of such projects.

2. APEID already offers attachment facilities. The Associated Centres should make more use of such facilities for obtaining the services of resource persons from other centres under APEID to exchange ideas and obtaining suggestions for improvements in their on-going programmes.

3. Appreciating the efforts made so far under APEID for promoting the development of low-cost equipment and materials and bringing out publications on 'How to make' such low-cost equipment, it is suggested that this activity should be continued and further expanded. For this purpose, the countries should be assisted to organize national workshops to develop designs of new items of such low-cost equipments. Examplars from the efforts of the national workshops should be selected and published by ACEID for wider dissemination.

4. As the development of appropriate instructional materials is very much needed if the approach to link science teaching to real-life situations is to be encouraged and facilitated, APEID should assist the countries to develop such materials for selected real-life situations and publish periodically such selected materials for wider dissemination. The co-operative development of such materials through sub-regional workshops also needs to be supported.

5. As problems relating to science equipment continue to be a major concern of all the participating countries, a regional seminar focusing on crucial issues in this regard should be organized to propose actions and measures to improve the position.

6. To evaluate science learning linked to real-life situations, a radical change in evaluation techniques and tools will be needed, and training for skills in developing new instruments will have to be provided. APEID should therefore organize a regional workshop to discuss these crucial problems and suggest ways of evaluating the science learning outcomes using the real-life situation approach.

7. Teachers will continue to be the pivot of the teaching-learning activity, and in order that the various curriculum development efforts undertaken so far bear fruit and the time and resources spent for this give optimum dividends, the problems of science teacher training should be critically looked into by a regional seminar to suggest the much needed changes, both for pre-service and in-service training and for providing continuous professional support for science teachers to help them link science learning more and more to real-life situations.

ANNEX I

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ANNEX II

AGENDA

1. Inauguration of the Workshop.

2. Election of the Officers of the Workshop.

3. Consideration of the Provisional Schedule of Work.

4. Presentation of and discussions on experiences of the National Workshop.

5. Development of guidelines for designing, developing and implementing science curricula to link them with real-life situations.

6. Alternative methods for preparing teachers in science and technology.

7. Recommendations for follow-up activities at the national and regional levels.

8. Adoption of the draft report.

ANNEX III

LIST OF SOME 'HOW TO MAKE'
LOW-COST SCIENCE EQUIPMENT

Bangladesh

Items	Grade	Purpose	Materials needed
1. Large smoke box	Lower secondary	To demonstrate: convection currents in the air; and various optical phenomenon	A cardboard box, a sheet of glass, 2 sheets of paper, 2 glass cylinders, a roll of touch paper, concave and convex lenses, prisms, mirrors
2. Simple electroscope	Lower secondary	To detect small electric charges and examine the nature of charges	Galvanized iron wire, 2 pith pieces, silk thread
3. Steam turbine	Lower secondary	To show that steam pressure generated by boiling water can do work such as rotating a wheel	Cylindrical tin can with tight-fitting lid, thin tin sheet and strip, straight iron wire, cork, 2 tiny solid rubber pieces
4. Common pump	Lower secondary	To demonstrate that atmospheric pressure forces fluid (water) to move from regions of higher pressure to regions of lower pressure, which can be utilized for drawing water from a reservoir	Clear plastic tube, 3 rubber corks, rubber sheet, iron rod, wood handle, glasstube, screws and nuts, rubber gum
5. Electroscope	Lower secondary and secondary	To detect small electric charges and to examine the nature of electric charges	A transparent plastic tumbler, brass strip, brass disc., drinking straw, screw, nuts, stapling pin PVC sheet, lump of dry paper or dry cloth

Items	Grade	Purpose	Materials needed
6. Simple microscope	Lower secondary	To produce magnified image of tiny objects to be used for exploring crystals, living micro-organisms, textile fibres, etc.	Tiny glass bead, piece of square-shaped plywood, small iron sheet angle, nut and long screw
7. Simple osmoscope	Secondary	To demonstrate osmosis in two liquids of different concentrations	Transparent plastic funnel, piece of fresh clean fish bladder, transparent plastic beaker, tripod stand, support stand and rod, long piece of thread, sugar
8. Simple transpiration apparatus	Secondary	To demonstrate that suction force is developed	Thin narrow glasstube, piece of thick strong rubber tube, small crucible, healthy plant twig with leaves, support stand and rod, tripod stand, mercury
9. Tongue depressor microscope	Lower secondary and secondary	To produce magnified image of tiny objects and to explore living micro-organisms, chemicals, crystals, fibres, etc.	Two tongue depressors (wood/plastic), small glass bead lens, nut and screw, and rubber bands

Indonesia

Items	Grade	Purpose	Materials needed
1. Water distillation equipment	Primary	To understand basic principle of distillation	Used milk can, board, wooden block, plastic hose, plastic tube, clothes line wire, rubber stoppers (3), spirit burner, plywood, nails
2. Wind vane	Primary	To help students know the wind direction and velocity	Plywood, wooden block, cycle tube valves, zinc piece, nails

Republic of Korea

Items	Grade	Purpose	Materials needed
1. Wind vane	1-6	to find out the wind direction	thin piece of wood about 10 cm. wide, glass part of a medicine dropper, soft wood about 1 m. in length
2. Colour wheel	1-6	to examine the mixing of colours	10 cm. plastic disk (1-1.5 mm. thickness), paints
3. Making rainbow colours	4-6	to make a rainbow	old atomizer or sprayer
4. Movement of air	4-6	to see the movement of air	vinyl tube, rubber balloons, pinch cork
5. Making simple hygrometer	5-9	to measure the humidity of air	cellophane strips about 30 cm. long, stand, weight, spool
6. A cloud in a bottle	5-6	to see how clouds are formed	ringer bottle, rubber stopper, cycle pump, rubber tubing
7. Volume change of air by heat	3-6	to see the change of volume of air on heating	tin can about 12 cm. in length and 5 cm. in diameter, thin rubber sheet, alcohol lamp
8. A device for estimating height of the sun	4-6	to estimate the height of the sun	hard board, paper, used ball point pen
9. Making a dial	4-6	to make a sun dial	cardboard, gnomon, glue
10. Simple spring balance	2-6	to measure weight	tin lid (scale pan), rubber band, supporting stick, weight
11. Simple tripod	3-6	to use a stand	tin can (cutting away the sides)
12. Germinating cup	4-6	to make a low-cost germinating cup	drinking glass, rectangular piece of blotter, cotton, sawdust

Items	Grade	Purpose	Materials needed
13. Building an aquarium	1-6	to keep the aquatic things living	bricks, frame of wood, vinyl sheet
14. Sprinkler bottle for iron powder	2-6	to find out the magnetic field of magnet	small bottle with plastic cap, many holes on the cap
15. Making substitute litmus	4-6	to get low-cost litmus paper	black soybean, glass cup, filter paper

Thailand

Items	Grade	Purpose	Materials needed
1. Heat conductivity	IX	to test heat conductivity of different objects	Aluminium cup; wooden handle; copper, aluminium, iron, glass, wood rods; rubber stoppers; screws
2. Conductivity apparatus	X, XI, XII	to test electrical conductivity of substances	PVC tube; nichrome wire; brass electrode; electric bulb; connecting wire; plugs
3. Electrolysis apparatus	VIII, XI	Electrolysis of water	Wooden block; electric wire, plastic cup; electrodes; test tubes; rubber bands
4. Calorimeter	XI, XII	To determine specific heats of substances	Styrofoam block; aluminium tube; terminals, rubber bands
5. Artificial lungs	XI	To study how lungs work	Plastic or glass cylindrical box; Y-shaped glass tube; rubber bands; balloons, scotch tape

APPENDIX

FIELD VISITS IN THAILAND

During the course of the Sub-regional Workshop, the participants had an opportunity to visit the following institutions to make an on-the-spot study of the on-going science teaching and science teacher training programmes to see how attempts to link science education to daily-life situations are being made:

1. Institute for the Promotion of Science and Technology Teaching (IPST), Bangkok
2. Watthanothaiphayap School, Chiangmai
3. Sarapi Pithyakom Junior High School, Chiangmai
4. Wat Changkien Primary School, Chiangmai
5. Teachers Training College, Chiangmai

1. Institute for the Promotion of Science and Technology Teaching (IPST)

This institute is responsible for all curriculum development work relating to science and mathematics at the national level. It enjoys a semi-autonomous status and has strong links with the Ministry of Education. The curriculum development work is undertaken through curriculum design teams. There are six design teams; one each for Chemistry, Physics, Biology, Physical Science, General Science, and Mathematics which work in close co-operation with each other. In addition, there are five servicing teams - Evaluation, Educational Innovation, Equipment, Store and Distribution, Public Relations. The membership of each design team consists of teachers, supervisors, teacher training college instructors and university lecturers.

The Chemistry programme has attempted to integrate text and laboratory manual with a view to encourage teachers to teach chemistry as a learner-centred inquiry, involving both theory and practice. A study of Thai chemical industries and chemical problems that are relevant to Thai society have been introduced which has helped much to bring the course closer to real-life situations.

Physics is presented as a single unified course containing elements from mechanics, heat, light and sound, electricity and magnetism, and laboratory experiments. Inexpensive equipment that can be manufactured locally is also developed.

The Biology course uses an activity-centred approach. Topics such as ecosystem, population, diet, nutrition, use data collected in Thailand thus helping the student to examine the biology of his immediate environment, which, in turn, links the teaching to a great extent to real-life situations. Another major attempt in biology is the development of biological materials available from the local environment for supply to science teaching centres.

Physical science course is a broad two-year modular course for non-science students which integrates physics, chemistry, earth science and some relevant life science topics. It examines the practical applications and the social implications of science and thus is closely related to real-life situations. Currently, 14 modules on topics such as Sun light and Energy; Colour; Good living; Electricity and electrical appliances; Synthetic substances; Natural resources and industry; Medicine and life are in use. Laboratory work is included as an integral part of theory.

The General Science Team is helping the Curriculum Development Centre of the Ministry of Education in developing the topics that relate to science in the 'Life Experience' area of the primary curriculum. Here also it is an integrated approach focusing on 'process skills' rather than 'product' of science. A number of very simple and inexpensive pieces of equipment have been designed. Currently, an interesting research study on training of teachers in process skills and questioning techniques is under way which is using programmed instructional materials. The whole course is very closely related to real-life situations and is fully activity based so as to provide,as much as possible,concrete experiences.

2. Watthanothaiphayap School

This is a secondary school with an enrolment of nearly 2500 students and a teaching staff of 150. Though originally started as a girl's school, it is now co-educational at the senior secondary stage. For science instruction, there is a separate block with excellent laboratory facilities and equipment. The science courses are using the materials developed by IPST. It is in the physical science and general science courses where many situations linking science learning to real-life were observed. Another area where a similar attempt has been made is in vocational subjects which are compulsory right from Grades VII-XII. In agriculture and home economics courses, science concepts and principles were being applied as well as learned from real-life situations. A very interesting class in physical science where electrical appliances were being studied provided an excellent opportunity to understand how science can be linked to real-life situations. Another such example was a biology class where, though the emphasis was on conceptualization, the many examples under the microscope slides were from blood cells.

3. Sarapi Pithyakom Junior High School

This is a junior high school in a semi-urban area with more than 700 students and a teaching staff of 36 out of which four are science teachers. Though the school has now its new building where facilities of a science room are being established, the classes were being run in thatched roof structures. The whole environment around the school has rich situations for linking science to real-life problems, and are being exploited to provide science learning experience through the agricultural farm as majority of the students are from homes where agriculture is the main activity of the family.

4. Wat Changkien Primary School

This is a primary school with an enrolment of 480 students and a teaching staff of 24. The whole science teaching programme is very closely related to real-life situations. The lesson in grade one on day and night, light and dark, and grade three on soils, and their water retention capacities were being learned through an activity approach which showed how this helps in making science more enjoyable and interesting for children. A good example of integrating subject areas in primary curriculum was seen in Grade III while teaching the topic on soils.

5. Teachers Training College, Chiangmai

The visit to the Teachers Training College was undertaken to specially study the programme of 'Science and Technology Teacher Servicing Centres (STSC)' which have been established in selected teachers training colleges to provide a continuing professional support and services to science teachers. The establishment of STSCs will also facilitate the decentralization of certain aspects of IPST's in-service teacher training work and school follow-up support programme.

The Science and Technology Teacher Servicing Centre of Chiangmai Teachers Training College is responsible for servicing 72 lower secondary schools and 12 upper secondary schools in two provinces, Chiangmai and Mae Hong Sorn. The objectives of the Centre are:

i) to provide locations where teachers can work together in improvising, producing and repairing low-cost science and mathematics equipments;

ii) to give in-service training to teachers in the production, maintenance and repair of science equipment and in the use of audio-visual materials;

iii) to advise teachers in academic subjects, modern teaching methodologies, evaluation and educational technology;

iv) to provide, on loan, rare materials, visual and audio-visual aids for use in the teaching of mathematics and science;

v) to provide and develop resource materials such as plants and animal specimens; and

vi) to serve the pre-service students as well as provide in-service to improve science and mathematics teaching and other teacher competencies.

Eighty staff members of the Training College are involved in science education and of these 22 are currently manning the servicing centre on a voluntary basis. The Centre has 7 units: Operational and Consultancy Unit; Academic Unit; Equipment Unit; Lower Secondary Science Unit; Mathematics Unit; Audio-visual Unit; and Living Specimen Unit. Each unit has a specialist in physics, chemistry, mathematics, and biology. Though the main function of the servicing centre is in-service programmes, the pre-service students can also use the facilities of the Centre for practice teaching. The needs of the school teachers are identified through visits and through questionnaires. Practice-teaching supervision also provides opportunities to the staff of the Centre to go out and find the need of the teacher and arrange in-service programmes based on these felt needs.

As the staff of the Centre is only part-time and their main responsibility is the pre-service programme, the flexibility of arranging the regular teaching programme of the teaching staff of the training college is an important requirement and is being provided for. The major problem is of co-ordination and ensuring that the teachers who are called for in-service programme are made available by the schools and concerned administrating units.

A major area of concern, not generally receiving enough attention during pre-service training, is the repair and maintenance of equipment and making simple equipment. The servicing centre has an important programme to provide for this type of training. If science education is to be linked more and more with real-life situations, the need for such training and of a resource centre are obvious.

APEID PUBLICATIONS RELATED TO SCIENCE EDUCATION

Unesco, P.O. Box 1425, Bangkok G.P.O., Bangkok, Thailand

1. *Science in basic functional education: philosophy, approaches, methods and materials; report. 1975*

2. *Science in basic functional education: links with real-life situations; report. 1975**

3. *Integrated science in the junior secondary school in Sri Lanka; study. 1976*

4. *Science in basic functional education; report (of a Module-Writing Workshop). 1977**

5. *The Institute for the Promotion of Teaching Science and Technology of Thailand; study. 1977*

6. *Selection, maintenance and repair of school science equipment; report. 1978*

7. *Physics curriculum development in Asia; report. 1978*

8. *Making and using low-cost educational materials; report. 1979*

9. *Universalizing education: strategies for development and use of instructional materials; report. 1979. (includes six projects on science education, and guidelines for the design, development and use of science instructional materials).*

10. *Designing instructional materials for general education and teacher training: a portfolio of experiences in Asia and Oceania. 1980 (includes a section on science education).*

11. *Self-learning modules for teachers (three of a series already published: (1) Soil salinity and your crops; (2) Good-bye waste; (3) Let's make our school clean and beautiful)*

12. *Linking science education to the rural environment -some experiences; report. 1980*

13. *Linking science education to real-life: curriculum design, development and implementation; report. 1980*

14. *Biology education in Asia; report. 1980*

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* Out of stock

The *Asian Programme of Educational Innovation for Development (APEID)*, initiated on the recommendation of the Third Regional Conference of Ministers of Education and Those Responsible for Economic Planning in Asia (May–June 1971, Singapore) and the authorization of the General Conference of Unesco at its seventeenth session (Paris, 1972), aims at stimulating and encouraging educational innovations linked to the problems of national development in the Asian region.

All projects and activities within the framework of APEID are designed, developed and implemented co-operatively by the participating Member States through their national centres which have been associated by them for this purpose with APEID.

The 21 countries in Asia and the Pacific participating in APEID are: Afghanistan, Australia, Bangladesh, China, India, Indonesia, Iran, Japan, Lao People's Democratic Republic, Malaysia, Nepal, New Zealand, Pakistan, Papua New Guinea, Philippines, Republic of Korea, Republic of Maldives, Singapore, Socialist Republic of Viet Nam, Sri Lanka and Thailand. Each country has set up a National Development Group (NDG) to identify and support educational innovations for development within the country and facilitate exchanges between countries.

The Asian Centre of Educational Innovation for Development (ACEID), an integral part of the Unesco Regional Office for Education in Asia and the Pacific in Bangkok, co-ordinates the activities under APEID and assists the Associated Centres (AC) in carrying them out.

The aims of APEID are:

- to stimulate efforts of the Member States to improve the quality of life of the people through creating and strengthening national capabilities for the development and implementation of innovations in education, both formal and non-formal;
- to encourage the Member States to make all groups (students, teachers, parents, village and community leaders, administrative personnel and policy makers) aware of the need for relevant changes in education (both formal and non-formal) as an essential pre-requisite for the improvement of the quality of life of the people;
- to promote understanding and appreciation of the differences in educational practices and approaches of the Member States, and thereby contribute to international understanding and the creation of a new international economic order.